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Spruce Budworms Handbook

North American Coniferophagous *Choristoneura*: A Bibliography

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In 1977, the United States Department of Agriculture and the Canada Department of the Environment agreed to cooperate in an expanded and accelerated research and development effort, the Canada/United States Spruce Budworms Program (CANUSA), aimed at the spruce budworm in the East and the western spruce budworm in the West. The objective of CANUSA was to design and evaluate strategies for controlling the spruce budworms and managing budworm-susceptible forests, to help forest managers attain their objectives in an economically and environmentally acceptable manner. This document contains corrections to the data base previously published in the "Spruce Budworms Bibliography" and supplements, printed under CANUSA auspices at the University of Maine, plus citations for publications that have appeared in print since the last supplement was distributed in August 1983.



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Spruce Budworms Program

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North American Coniferophagous *Choristoneura*: A Bibliography

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Numerous people deserve special mention for their cooperation and assistance rendered during this project; many were previously acknowledged in the “Spruce Budworms Bibliography” and subsequent supplements. Again we express our appreciation and thanks to each. Two librarians have been especially helpful: Barry Barner, Canadian Forestry Service, Maritimes Forestry Centre, Fredericton, NB; and Daniel Starr, formerly USDA Forest Service, National Agricultural Library, Beltsville, MD. Constance A. Plexman, Canadian Forestry Service, Great Lakes Forestry Centre, Sault Ste. Marie, ON, fulfilled many requests. Likewise, Margaret D. Cameron, Canadian Forestry Ser-

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Contents

Introduction	iv
Bibliography	1
Subject Index	453
Taxon Index	507
Author Index	537

Introduction

The spruce budworms are recognized as the most destructive defoliators of conifers in North America. Over the last half-century, science has made great strides in understanding these pests and in developing rational approaches to dealing with them. Budworm outbreaks are naturally recurring events in susceptible forests of the United States and Canada; it is only recently that society has come to value the spruce-fir resource to the extent that budworm suppression has been mandated. Accordingly, research to develop safe, effective, and practical strategies for managing spruce budworms and budworm-susceptible forests will continue.

This bibliography is intended to provide investigators and students working with *Choristoneura* convenient access to the relevant literature published through 1985. Citations include basic information about the spruce budworms and, to a certain extent, the jack pine budworm and other close relatives. The bibliography does not comprehensively treat the literature on control materials (chemical or biological characteristics, fate, environmental impacts, or application) unless the budworm—rather than the material—is the subject of the document.

Assembly of a comprehensive bibliography on North American *Choristoneura* was well underway before the outset of the Canada/United States Spruce Budworms Program (CANUSA) in 1977. CANUSA supported publication of the "Spruce Budworms Bibliography" (Jennings and others 1979) and compilation and publication of three supplements (Jennings and others 1981, 1982, 1983) through

cooperative agreements with the University of Maine at Orono. Those books were intended to assist investigators during the term of CANUSA and included literature of broader interest on control strategies, tactics, and materials.

This bibliography is arranged with consecutively numbered citations in alphabetical order by senior or corporate author. Citations are followed by author, subject, and taxon indices that are cross-referenced by citation number. Citation format is a USDA Forest Service interpretation of the "American National Standard for Bibliographic References" (ANSI Z39.29-1977). Abbreviations follow the "National Clearinghouse for Periodical Title Word Abbreviations, Word-Abbreviation List, 1971 Edition." Keywords describing document content are listed after each citation. The keywords generally follow the "Thesaurus of Entomology," "Terminology of Forest Science, Technology, Practice and Products," and "Common Names of Insects and Related Organisms." Most taxa have been checked against reputable sources. We have indexed by scientific names given in the original documents; however, in many cases we have indicated synonymy by showing the current status in brackets (e.g., *Archips fumiferana* [*Choristoneura fumiferana*]). Keywording was intended to be comprehensive; however, in some cases (e.g., pest conditions reports and literature reviews), keywording generally has been restricted to the coniferophagous *Choristoneura*.

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Keywords: spruce budworm; pheromone-baited traps; pheromones; pheromone-baited trap placement; Quebec; Newfoundland; Maine; New Hampshire; Vermont; New York; Michigan

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Keywords: western spruce budworm; Douglas-fir; white fir; subalpine fir; blue spruce; Engelmann spruce; defoliation; tree condition; population density; egg-mass density; increment reduction; New Mexico; Arizona

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Keywords: malathion; aerial spraying; larval sampling; population reductions; DDT; chemical control; spruce budworm; Maine

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Keywords: jack pine budworm; tree damage; tree mortality; forecasts; defoliation; population trends; Wisconsin

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Keywords: population fluctuations; historical aspects; two-year-cycle budworm; forest insects; British Columbia

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Keywords: forest insects; pest conditions; forest diseases; surveys; stand conditions; population fluctuations; defoliation; forecasts; pheromone-

baited traps; two-year-cycle budworm; British Columbia

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Keywords: forest insects; pest conditions; forest diseases; surveys; tree mortality; stand conditions; population fluctuations; defoliation; forecasts; pheromone-baited traps; two-year-cycle budworm; British Columbia

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budworm; Idaho; Montana; Wyoming

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control; western spruce budworm; Idaho;
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budworm; Idaho; Montana; Wyoming

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Keywords: forest insects; pest conditions; stand conditions; population fluctuations; western spruce budworm; Montana; Wyoming

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Keywords: forest insects; pest conditions; stand conditions; economics; population fluctuations; aerial surveys; western spruce budworm; Idaho; Montana; Wyoming

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Keywords: forest insects; pest conditions; stand conditions; population fluctuations; western spruce budworm; Idaho; Montana; Wyoming

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Keywords: forecasts; spruce budworm; pest conditions; New Brunswick; Nova Scotia; Prince Edward Island

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Keywords: spruce budworm; silviculture; Maine

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Keywords: spruce budworm; birds; predators; New Brunswick

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Keywords: DDT; aerial spraying; population fluctuations; pest conditions; spruce budworm; Quebec; Ontario; Saskatchewan; Manitoba

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Keywords: western spruce budworm; birds; ants; economics; forest management

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Keywords: pest conditions; spruce budworm; Ontario

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Keywords: aerial spraying; forecasts; spruce budworm; pest conditions; Ontario

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Keywords: control; forecasts; spruce budworm;
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Keywords: control; forecasts; spruce budworm;
pest conditions; Ontario

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Keywords: control; forecasts; spruce budworm;
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Keywords: control; forecasts; spruce budworm;
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Keywords: spruce budworm; forecasts; population density; aerial spraying; pest conditions; Ontario

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Keywords: control; forecasts; spruce budworm;
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Keywords: pest conditions; spruce budworm; Ontario

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Keywords: spruce budworm; jack pine budworm; pest conditions; forecasts; Ontario

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Keywords: spruce budworm; jack pine budworm; detection; forest insects; surveys; light traps; pheromone-baited traps; remote sensing; Canada

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Keywords: spruce budworm; western spruce budworm; two-year-cycle budworm; jack pine budworm; Modoc budworm; bibliographies

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Keywords: spruce budworm; larval dispersal; larval sampling; sticky traps; egg density; larval density; absolute populations; clear cutting; Maine

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Keywords: historical aspects; spruce budworm; Maine

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Keywords: historical aspects; development; parasites; predators; spiders; birds; ornamentals; lead arsenate; eggs; moth invasions; moths; defoliation; host trees; susceptibility; tree damage;

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Keywords: spruce budworm; microbial insecticides; efficacy; control; New Brunswick

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Keywords: spruce budworm; defoliation; aerial surveys; forecasts; population fluctuations; Nova Scotia

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Keywords: spruce budworm; forecasts; defoliation; population fluctuations; Nova Scotia

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Keywords: spruce budworm; pest conditions; Nova Scotia

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Keywords: spruce budworm; defoliation; egg-mass sampling; forecasts; aerial surveys; balsam fir; white spruce; red spruce; tree mortality; Prince Edward Island

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Keywords: spruce budworm; pest conditions; defoliation; egg-mass sampling; New Brunswick

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Keywords: egg-mass sampling; pest conditions; spruce budworm; stand conditions; forecasts; defoliation; surveys; Nova Scotia

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Keywords: spruce budworm; defoliation; egg-mass sampling; New Brunswick; Nova Scotia; Prince Edward Island

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Keywords: spruce budworm; pest conditions; defoliation; egg-mass sampling; Prince Edward Island

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Keywords: spruce budworm; DDT; fenitrothion; phosphamidon; spray timing; forecasts; hazard rating; defoliation; New Brunswick

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Keywords: spruce budworm; aerial surveys; defoliation; stand conditions; New Brunswick

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Keywords: fenitrothion; mexacarbate; forecasts; aminocarb; efficacy; aerial spraying; spray application rates; dosage; foliage protection; population reductions; egg-mass density; spruce budworm; egg-mass sampling; defoliation; New Brunswick; Nova Scotia

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Keywords: spruce budworm; microbial insecticides; efficacy; Nova Scotia; New Brunswick

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Keywords: spruce budworm; life history; recommendations; Eastern Canada

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Keywords: aerial surveys; forest insects; forecasts; stand conditions; defoliation; increment reduction; western spruce budworm; population density; evaluation; tree mortality; acephate; chlorpyrifos-methyl; pest conditions; forest diseases; Idaho

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Keywords: spruce budworm; tree mortality; defoliation; stand conditions; Michigan

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Keywords: spruce budworm; tree damage; tree mortality; Michigan

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Keywords: spruce budworm; tree damage; tree mortality; Michigan

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Keywords: spruce budworm; tree damage; tree mortality; Michigan

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economics; New Brunswick

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Keywords: aerial spraying; spruce budworm; DDT; defoliation; efficacy; egg-mass density; forecasts; New Brunswick

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Keywords: spruce budworm; aerial spraying; hazard rating; efficacy; DDT; forecasts; egg-mass density; defoliation; aquatic nontarget organisms; deposits; spray timing; New Brunswick

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Keywords: spruce budworm; aerial spraying; DDT; phosphamidon; weather; defoliation; efficacy; egg-mass density; forecasts; New Brunswick

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Keywords: chemical control; forecasts; silviculture; spruce budworm; stand management; New Brunswick

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Keywords: population models; generation survival; population dynamics; fecundity; DDT; age-interval survival; chemical control; aerial spraying; spray histories; survival rates; larvae; instars; eggs; spruce budworm; pupae; moths; sex ratios; New Brunswick

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Keywords: fecundity; pupal size; population dynamics; food quantity; food quality; DDT; tree condition; historical aspects; aerial spraying; spray histories; chemical control; environmental impacts; spruce budworm; New Brunswick

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Keywords: population dynamics; development rate; food quantity; food quality; DDT; environmental impacts; tree condition; sex ratios; larval development; residues; toxicity; defoliation; spruce budworm; New Brunswick

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Keywords: weather; population dynamics; moth dispersal; DDT; chemical control; aerial spraying; moth survival; spruce budworm; air movements; New Brunswick

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Keywords: pupal survival; population dynamics; parasites; insect mortality; food quantity; food quality; air temperature; DDT; chemical control; spruce budworm; aerial spraying; environmental impacts; New Brunswick

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Keywords: larval survival; population density; food quantity; food quality; weather; DDT; parasites; environmental impacts; chemical control; aerial spraying; population dynamics; parasitism; precipitation; phenology; tree condition; spruce budworm; New Brunswick

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Keywords: spruce budworm; pest conditions; Nova Scotia

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Keywords: spruce budworm; pest conditions; jack pine budworm; Ontario

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Keywords: spruce budworm; jack pine budworm; pest conditions; Ontario

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Keywords: jack pine budworm; pest conditions; New Brunswick

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Keywords: forecasts; stand conditions; forest insects; forest diseases; spruce budworm; defoliation; pest conditions; Nova Scotia; New Brunswick; Prince Edward Island

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Keywords: spruce budworm; forecasts; evaluation; population density; pest conditions; Nova Scotia; New Brunswick; Prince Edward Island

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Keywords: spruce budworm; forecasts; population density; pest conditions; forest insects; Nova Scotia; New Brunswick; Prince Edward Island

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Keywords: forest insects; pest conditions; forest diseases; forecasts; spruce budworm; defoliation; egg-mass sampling; population fluctuations; stand conditions; New Brunswick; Nova Scotia; Prince Edward Island

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Keywords: pest conditions; spruce budworm; New Brunswick; Nova Scotia; Prince Edward Island

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Keywords: pest conditions; spruce budworm; New Brunswick; Nova Scotia; Prince Edward Island

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Keywords: spruce budworm; pest conditions;; New Brunswick; Nova Scotia; Prince Edward Island

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Keywords: spruce budworm; microbial insecticides; pest conditions; New Brunswick; Nova Scotia; Prince Edward Island

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Keywords: spruce budworm; economics; tree growth; harvesting; chemical control; Maine

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Keywords: spruce budworm; marketing; salvage cutting; harvesting

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Keywords: spruce budworm; parasites; defoliation; aerial spraying; egg-mass density; dosage-mortality studies; population fluctuations; ground surveys; larval density; pupal density; light traps; moth sampling; forecasts; aerial surveys; Maine; Quebec; New Brunswick

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Keywords: spruce budworm; parasite introductions; parasites; defoliation; egg-mass density; DDT; aerial spraying; population fluctuations; ground surveys; larval density; pupal density; light traps; moth sampling; aerial surveys; Maine; Quebec; Eastern Canada; New York; Vermont; New Hampshire

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Keywords: spruce budworm; spray timing; light traps; moth sampling; parasites; forecasts; DDT; efficacy; aerial spraying; Maine; Quebec; Eastern Canada

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Keywords: spruce budworm; parasite introductions; parasites; defoliation; aerial surveys; light traps; moth dispersal; forecasts; population fluctuations; ground surveys; moth sampling; DDT; efficacy; Maine; Quebec; New Brunswick

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Keywords: spruce budworm; parasite introductions; ground surveys; aerial surveys; defoliation; forecasts; population fluctuations; light traps; moth sampling; Maine

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Keywords: spruce budworm; parasite introductions; parasites; moth dispersal; aerial surveys; ground surveys; defoliation; forecasts; population fluctuations; larval sampling; moth dispersal; light traps; moth sampling; Maine

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Keywords: spruce budworm; parasite introductions; parasites; aircraft; DDT; population fluctuations; defoliation; aerial surveys; light traps; forecasts; larval sampling; efficacy; moth sampling; weather; Maine; Quebec; New Brunswick

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Keywords: spruce budworm; larval sampling; defoliation; parasites; forecasts; population fluctuations; light traps; parasitism; moth sampling; Maine; Eastern Canada; Quebec

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Keywords: spruce budworm; defoliation; DDT; aircraft; larval sampling; parasites; light traps; moth dispersal; forecasts; moth sampling; efficacy; Maine; Eastern Canada

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Keywords: spruce budworm; aerial spraying; defoliation; weather; aircraft; DDT; efficacy; parasites; light traps; population fluctuations; forecasts; Maine; New Brunswick; Quebec

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Keywords: spruce budworm; larval sampling; defoliation; parasites; light traps; forecasts; moth sampling; Maine; Eastern Canada

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Keywords: spruce budworm; aerial spraying; larval sampling; defoliation; malathion; parasites; efficacy; DDT; egg-mass density; weather; forecasts; light traps; moth sampling; Maine; Eastern Canada; Quebec

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Keywords: spruce budworm; microbial insecticides; carbaryl; nontarget organisms; aquatic nontarget organisms; fishes; birds; residues; pheromones; salvage cutting; feeding deterrents; fungi; silviculture; economics; Maine

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Keywords: chemical control; aerial spraying; maps; historical aspects; spruce budworm; Maine

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Keywords: spruce budworm; pest conditions; Maine

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Keywords: life history; spruce budworm; Maine

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Keywords: spray deposits; carbamates; larval mortality; aerial spraying; chemical control; dosage-mortality studies; crowns; needles; dosage; spray droplet size; meteorological factors; population reductions; instars; spray formulations; Idaho

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Keywords: aerial spraying; spray deposits; chemical control; Montana

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Keywords: spray deposits; efficacy; chemical control; spruce budworm; larval mortality; spray deposit assessment; population reductions

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Keywords: aerial spraying; mexacarbate; western spruce budworm; deposits; Idaho

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Keywords: aerial spraying; dosage; aircraft; spray application equipment; spray formulations; spray applications; bioassays

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Keywords: spruce budworm; Maine

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Keywords: mexacarbate; efficacy; spruce budworm; aerial spraying; chemical control; dosage; population reductions; Maine

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Keywords: spruce budworm; microbial insecticides; efficacy; parasites; Quebec

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Keywords: spray deposits; spores; foliage; biological control; spray deposit assessment

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Keywords: spruce budworm; microbial insecticides; balsam fir; efficacy; dosage; spray deposits; Ontario

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Keywords: viruses; nuclear polyhedrosis viruses; entomopox viruses; spray formulations; efficacy; population reductions; spruce budworm; pathogen/chemical combinations; fenitrothion

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Keywords: pathogen/chemical combinations; larval mortality; branch sampling unit; aerial photography; crown levels; oviposition; long-term effects; parasites; parasitism; nontarget organisms; environmental impacts; integrated control; population density; larvae; larval density; buds; defoliation; foliage protection; dosage; acephate; persistence; population reductions; sublethal dosage; international units; spray deposits; spray formulations; spores; weather; spruce budworm; parasites; efficacy; aerial spraying

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Keywords: natural enemies; biological control; aerial spraying; long-term effects; pathogen/chemical combinations; entomopox viruses; nuclear polyhedrosis viruses; dosage; population density; population reductions; economics; viral transmission; spruce budworm; fenitrothion; efficacy; viruses

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Keywords: western spruce budworm; fungi; bacteria; microsporidia; protozoa; nematodes; nuclear polyhedrosis viruses; granulosis viruses; British Columbia

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Keywords: spruce budworm; microbial insecticides; efficacy; adjuvants; Ontario

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Keywords: aerial spraying; microbial insecticides; inclusion bodies; spray application rates; efficacy; spray droplet size; spores; crystal-forming bacteria; sampling methods; pathogens; nuclear polyhedrosis viruses; entomopox viruses; spray deposits; spray deposit assessment

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Keywords: microbial insecticides; spruce budworm

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Keywords: forest insects; aerial spraying; acephate; nontarget organisms; international units; population reductions; foliage protection; microbial insecticides; pathogen/chemical combinations; dosage; biological control; biochemical control; moths; spruce budworm; moth emergence; oviposition; spray application rates

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Keywords: pathogen/chemical combinations; foliage protection; forecasts; egg-mass density; defoliation; dosage; population reductions; long-term effects; microbial insecticides; efficacy; fenitrothion; spruce budworm; egg-mass sampling; larval sampling

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Keywords: pathogen/chemical combinations; efficacy; population reductions; larval parasites; pupal parasites; sublethal dosage; dosage; organophosphates; international units; spray deposits; foliage protection; microbial insecticides; spray application rates; long-term effects; moth emergence; moths; oviposition; egg parasites; aerial spraying; acephate; spruce budworm; fenitrothion; parasitism

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Keywords: aerial spraying; efficacy; parasites; environmental impacts; biological control; biochemical control; microbial insecticides; natural mortality; foliage protection; international units; acephate; pathogen/chemical combinations; population reductions; organophosphates; spray formulations; spruce budworm; adjuvants

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Keywords: pathogen/chemical combinations; aerial spraying; acephate; biological control; biochemical control; microbial insecticides; spruce budworm; dosage; spray formulations; efficacy

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Keywords: nuclear polyhedrosis viruses; cytoplasmic polyhedrosis viruses; fenitrothion; deposits; weather; efficacy; pathogens; aircraft; spray application equipment; entomopox viruses; parasitism; oviposition; egg viability; pathogen/chemical combinations; Ontario

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Keywords: fenitrothion; viruses; pathogen/chemical combinations; parasites; efficacy; biological control; biochemical control; environmental impacts; microbial insecticides; aerial spraying; dosage; entomopox viruses; nuclear polyhedrosis viruses; spray deposits; population reductions; foliage protection; sex ratios; larval mortality; moths; moth emergence; long-term effects; microsporidia; population density; egg-mass density; spruce budworm; eggs; parasitism; viral transmission

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Keywords: aerial spraying; spruce budworm; efficacy; microbial insecticides; chitinase; Ontario

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Keywords: spruce budworm; microbial insecticides; efficacy; defoliation; deposits; spray deposit assessment; Quebec

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Keywords: microbial insecticides; spruce budworm; dosage-mortality studies; efficacy

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Keywords: pathogens; spores; adjuvants; nuclear polyhedrosis viruses; weather; foliage; mist blowers; defoliation; larval density; population reductions; microbial insecticides; biological control

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Keywords: spruce budworm; microbial insecticides; efficacy; aerial spraying; Quebec; Ontario

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Keywords: spruce budworm; microbial insecticides; dosage-mortality studies

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Keywords: spruce budworm; western spruce budworm; microbial insecticides; efficacy; environmental impacts; nontarget organisms

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Keywords: spruce budworm; microbial insecticides; efficacy; recommendations

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Keywords: spruce budworm; hazard rating; mapping; vulnerability; New Brunswick

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Keywords: literature reviews; feeding; population fluctuations; control; host trees; spruce budworm; forecasts; forest management; outbreaks; New Brunswick; Nova Scotia; Prince Edward Island

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Keywords: population sampling; larval sampling; moth sampling; sampling methods; branch sampling unit; crown levels; spruce budworm; frass; moths; light traps; foliage; defoliation

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Keywords: insect mortality; population dynamics; statistics; age-interval survival

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Keywords: stand conditions; radial increment; tree growth; tree mortality; outbreaks; epidemic populations; historical aspects; stand composition;

species composition; spruce budworm; stand age; vulnerability; increment reduction; feeding; tree vigor; New Brunswick

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Keywords: population dynamics; historical aspects; spruce budworm; New Brunswick

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Keywords: insect mortality; population dynamics; population models; predictive equations; key factors; spruce budworm; forecasts; statistics

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Keywords: population models; population dynamics; age-interval survival; historical aspects; literature reviews; population density; stand conditions; generation survival; larval density; spruce budworm; weather; New Brunswick

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Keywords: population dynamics; weather; larval mortality; needle mining; flowering; egg populations; larval density; egg density; larval emergence; overwintering larvae; spruce budworm; larval dispersal; feeding; New Brunswick

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Keywords: generation survival; age-interval survival; eggs; larvae; pupae; fecundity; population dynamics; survival rates; spruce budworm; egg survival; larval survival; pupal survival; sex ratios; New Brunswick

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Keywords: silviculture; economics; forest management; spruce budworm; New Brunswick

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Keywords: spruce budworm; predators; birds; mammals; New Brunswick

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Keywords: New Brunswick

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Keywords: food supply; egg-mass density; larval dispersal; instars; larval mortality; population density; spruce budworm; dispersal; starvation; population dynamics; New Brunswick

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Keywords: spruce budworm; pest conditions; Saskatchewan

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Keywords: pest conditions; spruce budworm; jack pine budworm; Michigan

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Keywords: western spruce budworm; economics; chemical control; aerial spraying; stand conditions; efficacy; Oregon; Washington

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Keywords: pest conditions; spruce budworm; jack pine budworm; Wisconsin

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Keywords: pest conditions; forest insects; Ontario

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Keywords: pheromones; pheromone-baited traps; weather; spruce budworm; moth sampling

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Keywords: spruce budworm; pheromone-baited traps; pheromone-baited trap catches; pheromone-baited trap design; pheromone-baited trap placement; Ontario

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Keywords: spruce budworm; pheromones; mating disruption

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Keywords: spruce budworm; pheromones; pheromone-baited traps

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Keywords: aerial spraying; carbaryl; trichlorfon; insect mortality; forecasts; hazard rating; environmental impacts; population reductions; defoliation; tree mortality; spruce budworm; environmental monitoring; Maine; New Hampshire

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Keywords: spruce budworm; aerial spraying; carbaryl; acephate; trichlorfon; efficacy; stand conditions; forecasts; hazard rating; Maine

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Keywords: carbaryl; acephate; trichlorfon; microbial insecticides; spruce budworm; efficacy; stand conditions; forecasts; hazard rating; Maine

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Keywords: spruce budworm; carbaryl; aquatic nontarget organisms; Maine

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Keywords: acephate; carbaryl; trichlorfon; aquatic nontarget organisms; spruce budworm; Maine

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Keywords: acephate; carbaryl; trichlorfon; aquatic nontarget organisms; spruce budworm; Maine

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Keywords: spruce budworm; environmental impact statements; management options; Maine

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Keywords: spruce budworm; research; Eastern United States

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Keywords: western spruce budworm; Douglas-fir; DDT; aerial spraying; chemical control; New Mexico

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Keywords: western spruce budworm; environmental impact statements; management options; literature reviews; New Mexico

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Keywords: spruce budworm; pheromone-baited trap design

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Keywords: pest conditions; western spruce budworm

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Keywords: pest conditions; western spruce budworm

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Keywords: pest conditions; western spruce budworm

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Keywords: western spruce budworm; tree damage; increment reduction; tree mortality; aerial spraying; economics; DDT; spruce beetle; salvage cutting; Douglas-fir beetle; western blackheaded budworm; Montana; Idaho; Washington

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Keywords: tree mortality; weather; wind; silviculture; spruce budworm; Maine

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Keywords: spruce budworm; microbial insecticides; acephate; aminocarb; carbaryl; dimethoate; fenitrothion; methomyl; trichlorfon

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Keywords: western spruce budworm; aerial spraying; spray application equipment; aircraft; mexacarbate; Montana; Idaho

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Keywords: western spruce budworm; DDT; aerial spraying; malathion; efficacy; nontarget organisms; aquatic nontarget organisms; aircraft; safety; chemical control; Montana

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Keywords: spruce budworm; western spruce budworm; egg-mass sampling; Montana

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Keywords: western spruce budworm; environmental impact statements; management options; Idaho

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Keywords: spruce budworm; aerial spraying; DDT; efficacy; weather; defoliation; New Brunswick

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Keywords: aerial spraying; spruce budworm; defoliation; DDT; efficacy; New Brunswick

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Keywords: spruce budworm; efficacy; DDT; aircraft; spray application equipment; forecasts; tree mortality; surveys; New Brunswick

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Keywords: spruce budworm; aerial spraying; DDT; population sampling; spray timing; efficacy; nontarget organisms; New Brunswick

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Keywords: spruce budworm; aerial spraying; DDT; efficacy; nontarget organisms; population trends; New Brunswick

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Keywords: spruce budworm; aerial spraying; economics; defoliation; population sampling; efficacy; parasites; predators; New Brunswick

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Keywords: spruce budworm; aerial spraying; DDT; Eastern Canada

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Keywords: aerial spraying; efficacy; historical aspects; foliage protection; tree mortality; tree condition; outbreaks; spruce budworm; epidemic populations; New Brunswick

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Keywords: aerial spraying; larval mortality; population reductions; moth emergence; chemical control; foliage protection; spruce budworm; tree damage; foliage; New Brunswick

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Keywords: aerial spraying; economics; efficacy; spruce budworm; New Brunswick

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Keywords: aerial spraying; spray timing; efficacy; shoot growth; foliage protection; tree mortality; weather; phenology; tree damage; defoliation; population reductions; economics; dosage; population density; feeding; spruce budworm; spray drift; larval development; aerial surveys; New Brunswick

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Keywords: aerial spraying; maps; historical aspects; phenology; chemical control; shoot growth; spruce budworm; spray timing; New Brunswick

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Keywords: aerial spraying; chemical control; dosage; population reductions; foliage protection; forecasts; outbreaks; spruce budworm; New Brunswick; Quebec

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Keywords: detection; defoliation; hazard rating; spruce budworm; aerial surveys; ground surveys; New Brunswick

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Keywords: spruce budworm; DDT; aerial spraying; efficacy; New Brunswick; Quebec

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Keywords: egg-mass sampling; historical aspects; spruce budworm; egg-mass density; New Brunswick

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Keywords: aerial spraying; spruce budworm; aquatic nontarget organisms; DDT; New Brunswick

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Keywords: spruce budworm; efficacy; aerial spraying; DDT; spray application equipment; nontarget organisms; parasites; New Brunswick

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Keywords: aerial spraying; efficacy; historical aspects; tree mortality; stand structure; spruce budworm; chemical control; New Brunswick

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Keywords: aerial spraying; spruce budworm; DDT; aquatic nontarget organisms; New Brunswick

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Keywords: aerial surveys; defoliation; spruce budworm; New Brunswick

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Keywords: spruce budworm; silviculture; New Brunswick; Nova Scotia

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Keywords: spruce budworm; balsam fir; white spruce; aerial surveys; tree mortality; Minnesota

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Keywords: spruce budworm; jack pine budworm; pest conditions; historical aspects; Ontario

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Keywords: spruce budworm; jack pine budworm; pest conditions; historical aspects; Ontario

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Keywords: spruce budworm; jack pine budworm; pest conditions; historical aspects; Ontario

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Keywords: spruce budworm; jack pine budworm; pest conditions; historical aspects; Ontario

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Keywords: spruce budworm; jack pine budworm; pest conditions; historical aspects; Ontario

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Keywords: spruce budworm; chemical control; surveys; Maine

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Keywords: air temperature; evaporation rates; aggregation; larvae; instars; larval behavior; spruce budworm

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Keywords: weather; population fluctuations; air movements; rain; cloud cover; outbreaks; epidemic populations; relative humidity; population density; spruce budworm

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Keywords: spruce budworm; birds; predation; Ontario

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Keywords: silviculture; tree age; tree condition; harvesting; spruce budworm; forest management; susceptibility

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Keywords: spruce budworm; forest management; selection system; Maine

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Keywords: western spruce budworm; DDT; efficacy; economics; aerial spraying; Oregon

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Keywords: western spruce budworm; tree mortality; stand conditions; population trends; evaluation; egg-mass density; forecasts; population density; life history; defoliation; parasites; Douglas-fir; true fir; Colorado; Wyoming

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Keywords: spruce budworm; balsam fir; white spruce; microsporidia; parasites; synthetic diets

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Keywords: microsporidia; biological control; spray formulations; pathogens; spray timing; microbial insecticides; ground spraying; larvae; instars; moths; spores; larval infection; moth diseases; mist blowers; Ontario

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Keywords: spruce budworm; tree damage; jack pine budworm; Central North America

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Keywords: oviposition; egg-mass sampling; sampling methods; needle density; thigmotaxis; illumination; egg masses; light reactions; host tree preferences; host trees; moths; moth behavior; oviposition sites; needles; branch sizes; crown levels; defoliation; spruce budworm; Minnesota

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Keywords: pest conditions; spruce budworm; jack pine budworm; Wisconsin

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Keywords: pest conditions; spruce budworm; jack pine budworm; Wisconsin

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Keywords: pest conditions; jack pine budworm; Wisconsin

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Keywords: pest conditions; western spruce budworm; British Columbia; Yukon Territory

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Keywords: western spruce budworm; two-year-cycle budworm; pest conditions; British Columbia; Yukon Territory

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Keywords: spruce budworm; western spruce budworm; two-year-cycle budworm; pest conditions; British Columbia; Yukon Territory

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Keywords: western spruce budworm; efficacy; DDT; Colorado

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Keywords: parasites; parasite biology; parasitism; evolution; parasite diversity; biogeography; parasite host preferences; spruce budworm; European fir budworm

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Keywords: parasites; spruce budworm; biogeography

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Keywords: fenitrothion; residues; parasites; parasitism; parasite biology; viruses; parasite mortality; outbreaks; epidemic populations; parasite reproduction; weather; spruce budworm; hyperparasites; parasite alternate hosts; pupal parasites; larval parasites

4318. Zylstra, B. F.; Obarymskyj, A. Experimental aerial applications of permethrin, carbaryl and chlorpyrifos-methyl for control of eastern spruce budworm *Choristoneura fumiferana* (Clem.) in New Brunswick in 1980. FPM-X-56. Sault Ste. Marie, ON: Canadian Forestry Service, Forest Pest Management Institute; 1981. 14 p.

Keywords: permethrin; carbaryl; chlorpyrifos-methyl; spruce budworm; spray application equipment; aerial spraying; efficacy; defoliation; New Brunswick

SUBJECT INDEX

- abiotic environment 2714, 3670, 3827, 4124, 4133, 4188
- abnormalities 2397, 2803, 3071, 3078, 3085, 3097, 3504
- absolute populations 1854, 2648
- acephate 152, 153, 156, 157, 234, 238, 518, 523, 585, 589, 602, 691, 726, 727, 731, 737, 1011, 1050, 1056, 1096, 1126, 1173, 1212, 1275, 1329, 1360, 1363, 1560, 1641, 1644, 1662, 1726, 1728, 1730, 1745, 1761, 1762, 1789-1792, 1883, 1884, 1983-1985, 1995, 2097, 2100, 2114, 2117, 2118, 2166, 2246, 2251, 2281, 2283-2286, 2294, 2333, 2422, 2423, 2474, 2504, 2599, 2605, 2607, 2609-2611, 2615, 2746, 2766, 2800, 2958-2960, 2964, 3006, 3007, 3010, 3013-3016, 3075, 3100, 3114, 3132, 3135, 3139, 3156, 3157, 3268, 3345, 3573, 3623, 3624, 3626-3629, 3633, 3635, 3636, 3640, 3694, 3695, 3807, 3809, 3810, 3814, 3815, 3821, 3824, 3825, 3925, 3926, 3948, 3951, 4177, 4292, 4293
- acetylcholinesterase 174, 624, 1127, 1153, 1782, 1883, 1884, 2350, 2793, 2913, 2958, 2960, 3777, 4314
- adjuvants 1268, 1663, 1730, 1925, 2151, 2363, 2602, 2610, 2618, 2625, 3321, 3549, 3827, 4158, 4161
- adulticides 594, 1528, 1532, 1945, 2474, 3334, 3742
- aerial detection 165, 172, 197, 461, 858, 1116, 1439, 1658, 1659, 1661, 2065, 2701, 3025, 3026, 3204, 3300, 3441, 3567, 3673, 4039
- aerial dusting 3658, 3660
- aerial photography 25, 162, 163, 165, 308, 769, 1582, 1587, 1593, 1697, 1812, 2007, 2146, 2334, 2335, 2583, 2599, 2654, 2694, 2698, 2699, 2701, 2770-2772, 3300, 4039, 4108
- aerial spray simulator 2621, 2746, 3099
- aerial spraying 74, 76-78, 80, 86, 87, 90, 92, 94, 104, 105, 109, 111, 113, 116, 118, 121, 130, 150, 152, 154, 155, 157-159, 183-185, 187, 188, 193, 201, 211-213, 228, 234, 237-241, 289, 292, 293, 296, 307, 321, 325, 336, 397, 402, 404, 408, 410, 412-415, 417, 419-421, 425, 430, 436, 444, 446, 450, 454, 455, 458-460, 462, 467, 490, 500, 528, 544, 553, 578, 581, 582, 587, 589, 591, 593, 595, 596, 598, 600, 602, 605, 618, 620, 636, 637, 645, 651, 712, 725, 731-739, 742, 748, 749, 757, 758, 763, 782, 815, 827, 828, 838, 844, 861, 862, 864-866, 875, 876, 905, 909, 911, 913, 914, 938, 942, 943, 947, 949, 951, 952, 958, 961-963, 965-968, 979-981, 983, 986, 991, 994, 999, 1008, 1010-1012, 1014, 1019, 1025, 1045, 1052, 1057, 1060, 1063, 1064, 1066, 1068, 1088, 1096-1099, 1102, 1114, 1118, 1129, 1130, 1146-1149, 1156, 1160, 1166, 1171, 1179, 1181, 1182, 1186, 1187, 1197, 1211-1213, 1261, 1263, 1288, 1289, 1299, 1302-1306, 1315, 1326, 1327, 1340-1344, 1347, 1363, 1388, 1409, 1410, 1413, 1414, 1416, 1418, 1436, 1448, 1463, 1468, 1481, 1482, 1484, 1486, 1520, 1526, 1528, 1532, 1542, 1556, 1576, 1597, 1624, 1687, 1688, 1690, 1691, 1694, 1700, 1720, 1726, 1728-1730, 1745, 1753, 1758-1763, 1768, 1770, 1771, 1783, 1791, 1801, 1808, 1811, 1812, 1820, 1864, 1870, 1871, 1873, 1876, 1878, 1882, 1890, 1897, 1937-1940, 1944, 1945, 1948, 1967, 1968, 1984, 2009, 2010, 2015, 2018, 2028, 2047, 2070, 2074, 2096, 2106, 2114, 2115, 2167-2170, 2172-2175, 2177, 2181, 2184-2186, 2188-2195, 2197, 2200, 2251-2255, 2262, 2264, 2266, 2269, 2271, 2273, 2274, 2277, 2281, 2286, 2291, 2297, 2305, 2306, 2320, 2331, 2336, 2338, 2339, 2342, 2345-2348, 2363, 2364, 2422, 2423, 2465, 2472, 2476, 2488-2491, 2504, 2516, 2519, 2570, 2593, 2599, 2600, 2603, 2607, 2609-2611, 2613, 2614, 2619, 2621, 2662, 2685, 2703-2708, 2712, 2718, 2735, 2740, 2745, 2746, 2749-2753, 2764, 2767, 2773-2776, 2798, 2799, 2804, 2832, 2839, 2840, 2842, 2845, 2847, 2854, 2856, 2857, 2894-2896, 2912, 2920, 2921, 2937, 2942, 2952, 2961, 2966, 2978, 2981, 2982, 2985-2990, 3029, 3065, 3066, 3089,

- 3096, 3156, 3194, 3196, 3197, 3215, 3254, 3274, 3299, 3306, 3315, 3318, 3342, 3345, 3350, 3351, 3403, 3406, 3445, 3448, 3451, 3454, 3463, 3468, 3474, 3476, 3477, 3481, 3483, 3485, 3486, 3497, 3500, 3511, 3519, 3525, 3547, 3548, 3567-3569, 3574, 3600, 3610, 3647-3649, 3656, 3659, 3660, 3663, 3681, 3682, 3690, 3691, 3694, 3698, 3699, 3701, 3702, 3705, 3706, 3709, 3710, 3717, 3720, 3730, 3731, 3746, 3749, 3774-3777, 3801, 3809, 3813, 3814, 3818, 3827, 3856, 3862, 3863, 3868, 3870, 3891, 3895, 3896, 3900, 3904, 3910, 3922, 3923, 3930, 3931, 3951, 3954-3956, 3981, 3983, 3984, 3987-3990, 3994, 3995, 4000, 4010, 4023, 4026, 4037, 4066, 4067, 4069-4085, 4087, 4089, 4090, 4092, 4095-4100, 4109, 4149-4153, 4156, 4158, 4168, 4169, 4183, 4252, 4260, 4273, 4274, 4302, 4305-4307, 4310, 4318
- aerial surveys 25, 50, 98, 172, 196, 211, 343, 344, 459, 501, 631, 632, 750, 780, 783, 785, 803-806, 810, 811, 814, 1001, 1005, 1006, 1096, 1109, 1246, 1247, 1328, 1357, 1362, 1438, 1439, 1540, 1554, 1571, 1582, 1619, 1659, 1664, 1685, 1812, 1821, 1926, 1929, 1936, 1944, 1948, 1986, 1987, 1991-1994, 2005, 2076, 2107, 2112, 2113, 2117, 2118, 2253, 2254, 2256-2259, 2302, 2343, 2441, 2497, 2549, 2558, 2560, 2578, 2661, 2672, 2687, 2693-2695, 2699, 2701, 2773, 2893, 2897, 3025, 3026, 3145, 3204, 3246, 3300, 3433, 3441, 3567, 3625, 3673, 3706, 3709, 3711, 3718, 3720, 3728, 3731, 3838, 3840, 3845, 3848, 3849, 3908, 3945, 4026, 4039, 4055, 4081, 4086, 4102, 4107, 4108, 4139, 4152, 4240, 4250, 4271
- aerosols 2150, 3107, 3129
- age-interval mortality 2464, 2657, 2714, 2943
- age-interval survival 654, 2184, 2185, 2188, 2197, 2383, 2384, 2388, 2459, 2464, 2475, 2633, 2641, 2645, 2646, 2657, 2658, 2677, 2679, 3338, 4049
- aggregation 653, 4128, 4131
- air movements 1539, 2189, 3372, 4132, 4133, 4135
- air quality 876, 1209, 3095, 4257
- air temperature 306, 425, 439, 635, 1168, 1281, 1669, 2185, 2190, 2192, 2469, 2647, 2866, 3175, 3224, 3228, 3251, 3256, 3281, 3338, 3358, 3372, 3446, 3465, 3469, 3507, 3736, 3738, 3744, 4011, 4125, 4126, 4128, 4129, 4131, 4133, 4213
- aircraft 80, 211, 233, 237-239, 323, 326, 327, 402, 528, 605, 620, 645, 725-727, 731-737, 741, 764, 876, 913, 965, 1009, 1037, 1096, 1138, 1146-1148, 1153, 1156, 1186, 1187, 1197, 1216, 1327, 1340-1342, 1344, 1808, 1811, 1948, 1956, 1987, 2074, 2114, 2259, 2261, 2262, 2274, 2286, 2339, 2516, 2612, 2695, 2767, 2840, 2845, 2847, 2854, 2982, 2987, 2988, 3196, 3342, 3461, 3464, 3471, 3477, 3483, 3487, 3525, 3610, 3631, 3656, 3663, 3673, 3690, 3701, 3705, 3730, 3774, 3862, 3895, 3896, 3923, 3930, 3931, 3954-3956, 4068, 4109, 4149, 4151, 4153, 4156
- aircraft guidance systems 153, 725, 1072, 2982, 3350, 3487, 4276
- Alaska 926, 1525, 1570, 1572, 1717-1719, 3864, 3865
- Alberta 545, 613-615, 617, 721, 750, 751, 1201, 1444, 1695, 1696, 1814, 1816, 2562, 2563, 2899, 2901, 2902, 3141-3143, 3354-3356, 3358, 3360, 3361, 3370, 3432, 3501, 3502, 3608, 3614, 3615, 3653, 3828, 3829
- aldrin 338, 3320, 3321, 3496
- alpine fir 501, 1830
- alternate hosts 2454
- ambrosia beetles 4140
- American aspen beetle 1813
- American chestnut 3886

- American redstart 622, 623
- American woodcock 4278
- amino acids 1140, 1142-1144, 1675, 1736, 1739, 1951, 2226, 4121
- aminocarb 40, 152, 153, 156, 336, 337, 409, 455, 507, 549, 581, 587-590, 595, 598, 622, 623, 628, 629, 691, 726, 727, 731, 732, 735-737, 739, 740, 800, 985, 991, 992, 994, 1010-1012, 1046, 1115, 1126, 1153, 1162, 1173, 1178, 1180, 1195, 1211-1213, 1385, 1594, 1597, 1622, 1662, 1663, 1716, 1761, 1762, 1808, 1925, 1938, 1944, 1952, 1956, 1957, 2014, 2022, 2046, 2166, 2200, 2277, 2280, 2394-2396, 2422, 2423, 2474, 2491, 2510, 2718, 2721, 2729, 2732, 2737, 2740, 2743, 2799, 2800, 2853, 2854, 2856, 2857, 2882, 2883, 2894, 2920, 2962, 2989, 2992, 3066, 3074, 3075, 3096, 3104, 3132, 3135, 3345, 3405, 3545, 3546, 3600, 3734, 3742, 3774, 3777, 3807, 3811, 3812, 3925, 3980, 3988, 3989, 4088
- amphibians 578, 585, 590, 1048, 1054, 1064, 2774, 2894, 2952, 3104, 3268, 3682
- annual rings 821, 2154, 2397, 3355, 3356, 3520, 3621, 3673, 3676-3679
- antennae 22-24, 3184, 3224, 3552
- antibiotics 1547, 1610, 3743, 4204
- ants 279, 652, 653, 655, 658-660, 664, 702, 1276, 1319, 1400, 1441, 1835, 1855, 1901, 2417, 2696, 2697, 3242, 3243, 3318, 3332, 3788, 4297, 4298, 4300
- aphids 558, 3048
- aquatic nontarget organisms 9, 111, 296, 365, 549, 556, 584, 588-594, 596, 598, 619, 726, 727, 742, 800, 827, 828, 844, 869-872, 1043, 1054, 1058, 1065-1067, 1115, 1150, 1158-1162, 1165, 1166, 1173, 1179, 1180, 1195, 1211-1213, 1216, 1301, 1304, 1326, 1370, 1416, 1446, 1458-1465, 1471, 1489, 1496, 1497, 1519, 1520, 1523, 1524, 1556, 1621, 1638, 1708, 1716, 1782, 1783, 1793, 1897, 1939, 1952-1955, 2010, 2014, 2015, 2018, 2166, 2167, 2172-2174, 2197, 2199, 2200, 2265, 2280, 2350, 2415, 2505, 2519, 2706, 2707, 2709, 2710, 2718, 2733, 2745, 2755, 2774, 2775, 2793, 2840, 2842, 2847, 2882, 2883, 2896, 2913, 2942, 2952, 2959-2961, 2986, 3029, 3073, 3408, 3420, 3680, 3701, 3799, 3816-3826, 3870, 3910, 3923, 3931, 3983, 3984, 3989, 4023, 4075, 4083, 4096, 4100, 4161
- Arizona 2-4, 6, 7, 238, 470, 2076, 2077, 2339, 2835, 3111, 3140, 3163, 3604, 3606, 3903, 4013, 4022
- aspen 1508, 1657, 1781, 2134, 4063
- aspen leaf beetle 1813, 1815
- aspen leafminer 3357
- aspen leaftier 1815
- associated Coleoptera 3032, 3174, 3423, 3665, 3668, 3673, 3748
- associated Hymenoptera 1421, 1835
- associated insects 316, 880, 1062, 2677, 2941, 4182
- associated Lepidoptera 397, 706, 712, 1399, 2093, 2401, 2402, 2450, 2527, 2530, 2531, 2764, 3046, 3405, 3542, 3544, 3601, 3605, 3606, 3673, 3687, 3833, 4058, 4059
- Atlantic salmon 1339, 2200
- Avermectin B1 3133
- AY 22342 2810
- azamethiphos 153, 984
- bacteria 69-71, 243, 613-615, 636, 1257, 1333, 1494, 1652, 1653, 1699, 1891, 2034, 2120, 2270, 2601, 2621, 2625, 2714, 2745, 2798, 2943, 3064, 3443, 3500, 3563, 4064

bacterial inhibition 2034

balsam fir 15, 18, 19, 29, 46, 89, 114, 138, 154,
161, 176, 219-222, 243, 244, 248, 260, 261,
266, 274, 275, 285, 307, 309, 341, 357, 358,
363, 405, 409, 423, 424, 429, 431, 451-453,
456, 468, 469, 471, 473, 477-479, 503, 514,
515, 621, 628, 692, 726, 730, 738-740, 888,
892, 894, 896, 905, 913, 917, 919, 937, 964,
969, 982, 984, 1017, 1039, 1071, 1079, 1081,
1082, 1174, 1176, 1200, 1290-1292, 1313,
1322, 1336, 1361, 1363, 1367, 1371, 1380,
1382, 1389, 1392, 1393, 1395, 1430, 1435,
1438, 1449, 1488, 1491, 1499, 1508, 1531,
1564, 1579, 1595-1597, 1623, 1625-1627, 1629-
1637, 1647, 1657, 1667, 1698, 1756, 1762,
1777, 1781, 1795, 1816, 1841, 1847, 1877,
1901, 1929, 1935, 1942, 1971, 2000, 2050,
2052, 2060, 2091, 2132, 2134, 2135, 2145,
2146, 2182, 2208-2214, 2216-2220, 2222, 2230,
2232, 2303, 2309, 2312, 2318, 2327, 2334,
2335, 2345, 2405-2407, 2419, 2420, 2453,
2456, 2468, 2493, 2509, 2514, 2516-2518,
2533, 2534, 2558, 2561, 2564, 2581, 2592,
2594, 2597, 2684, 2689, 2691, 2693, 2694,
2755, 2757, 2771, 2772, 2785, 2788, 2789,
2791, 2792, 2795, 2875, 2877, 2892, 2905-
2911, 2925, 2930, 2994, 2996, 2997, 3000,
3001, 3004, 3005, 3008, 3009, 3011, 3012,
3019, 3037, 3062, 3122, 3174, 3176, 3208,
3255, 3309, 3324, 3328, 3336, 3337, 3341,
3351, 3376, 3379-3381, 3414, 3415, 3419,
3425-3432, 3436, 3445, 3463, 3464, 3478,
3499, 3512, 3513, 3519, 3526-3529, 3531,
3537, 3538, 3575, 3595, 3612, 3616, 3618,
3641, 3739, 3750, 3798, 3929, 3933, 3934,
3937, 3942, 3946, 3957, 3966-3968, 3985,
3995, 3997, 4023, 4101, 4107, 4108, 4110,
4157, 4162, 4165, 4197, 4203, 4208, 4212,
4218, 4237, 4242, 4243, 4274, 4309, 4313

balsam fir bark beetle 243

balsam fir sawfly 505, 914, 1815, 2885

balsam gall midge 505

balsam twig aphid 505, 2518, 3979

balsam woolly adelgid 363, 524, 673, 1393, 2374,
2561, 2994, 3619, 3965

bark beetles 249, 317, 318, 400, 450, 487, 804,
1243, 1531, 1660, 1776, 1812, 2691, 2890,
2940, 3665-3667, 3671, 3748, 4027, 4140, 4293

barometric pressure 1669, 1670

basal area 1628, 2154, 3853, 3889, 3959, 4181

BAY SIR 8514 1275, 1861, 3066, 3075, 3123,
3124, 3136, 3137

bay-breasted warbler 622-624, 2566, 2656, 2666

beating foliage 2477, 4215

beech scale 194

behavior 35, 287, 543, 1798, 2377, 2822, 3317,
4127, 4135

bendiocarb 2115, 3016

benthos 594, 1166, 2961, 2962

benzene hexachloride 130, 153, 336, 542, 3320,
3321

bibliographies 215, 242, 619, 841, 889, 961, 1456,
1457, 1553, 1844-1846, 1856, 1874, 2663,
3356, 3424, 3943

bioassays 351, 353, 354, 488, 564, 1128, 1267,
1268, 1521, 1552, 1850, 1889, 2046, 2078,
2274, 2389, 2424-2428, 2524, 2569, 2664,
2738, 2819, 3090, 3109, 3110, 3125, 3130,
3133, 3138, 3139, 3226, 3319, 3552, 3683,
3749, 3972, 3975, 4065, 4191

biochemical control 565, 586, 636, 1055, 1411,
1819, 2043, 2044, 2607, 2610, 2611, 2613,
2804, 2805, 2812, 3068, 3073, 3088, 3091,
3215, 3251, 3313, 3318

bioenergetics 3038, 3040

bioethanomethrin 3121

biogeography 1579, 4001, 4315, 4316

biological control 62, 96, 112, 120, 124, 127, 128, 178, 200, 213, 295, 303, 364, 393, 394, 397, 398, 415, 419, 420, 436, 443, 445, 459, 463, 487, 561, 575, 598-600, 610, 619, 637, 640, 673, 676, 690, 716, 748, 749, 792, 835, 837, 866, 905, 971, 977, 1045, 1100, 1120, 1121, 1123, 1124, 1173, 1257, 1306, 1314, 1321, 1345, 1420, 1447, 1485, 1487, 1495, 1542, 1572, 1609, 1650, 1652, 1780, 1803, 1891, 1892, 1898, 1954, 1967, 1968, 2021, 2063, 2104, 2301, 2373, 2374, 2377, 2383, 2402, 2417, 2455, 2462, 2465, 2479, 2489, 2497, 2512, 2513, 2516, 2532, 2548, 2554, 2565-2567, 2596, 2600, 2607, 2610, 2611, 2613, 2618, 2636, 2658, 2663, 2745, 2764, 2825, 2860, 2943, 2950, 2952, 3045, 3177, 3306, 3446, 3453, 3458, 3459, 3465, 3469, 3471, 3472, 3476, 3477, 3485, 3487, 3533, 3560, 3561, 3572, 3656, 3686, 3768, 3827, 3887, 3972, 4022, 4047, 4050, 4064, 4154, 4173, 4192, 4207, 4209, 4210

bioluminescence 1521, 2424-2428, 2664, 3683

biomass 2924, 3682

biotic environment 1106, 1507, 3365, 3670

birch dieback 441, 450, 1624, 2677

birch skeletonizer 1756

bird behavior 1818, 3197, 4312

bird clutch size 2667, 4312

bird density 2532, 2667, 2895, 3197, 3261, 3418

bird mortality 2894, 3408

bird populations 2768, 3408, 3418

bird territories 2768, 2895, 3197, 4312

birds 29, 111, 296, 297, 305, 342, 463, 465, 507, 550, 578, 581, 584-596, 598, 600, 622-625, 652,

653, 655, 658, 659, 662, 664, 702, 742, 837, 883-889, 901, 975, 1018, 1019, 1034, 1035, 1043, 1048, 1054, 1063, 1115, 1122-1124, 1126, 1149, 1173, 1211-1213, 1217, 1315, 1318, 1351, 1377, 1400, 1429-1431, 1441-1443, 1447, 1448, 1470, 1512, 1555, 1667, 1709, 1785-1787, 1792, 1813, 1817, 1818, 1840, 1859, 1883, 1884, 1919, 1956, 1957, 1988, 2057, 2160, 2166, 2197, 2265, 2279, 2324, 2326, 2333, 2394-2396, 2415, 2457, 2505, 2510, 2532, 2566, 2567, 2639, 2655, 2656, 2661, 2667, 2702, 2707, 2709, 2718, 2721, 2733, 2737, 2740, 2743, 2745, 2755, 2774, 2775, 2797, 2798, 2840, 2842, 2852, 2854-2857, 2894, 2895, 2916, 2952, 2986, 3174, 3197, 3221, 3261, 3314, 3408, 3418, 3442, 3513, 3567, 3612, 3681, 3685, 3686, 3788, 3789, 3792, 3910, 3963, 3984, 3987, 3989, 4137, 4138, 4312, 4314

black army cutworm 3357

black flies 1878, 2961

black spruce 15, 19, 29, 137, 161, 258, 274, 341, 431, 433, 453, 473, 479, 516, 692, 739, 894, 896, 1039, 1322, 1392-1394, 1488, 1531, 1564, 1579, 1597, 1667, 1744, 1756, 1762, 1776, 1777, 1841, 1879, 1942, 2052, 2056, 2209, 2210, 2212, 2216, 2220, 2303, 2321, 2327, 2345, 2420, 2509, 2514, 2516, 2533, 2558, 2592, 2689, 2694, 2772, 3000, 3001, 3146, 3147, 3308, 3537, 3538, 3541, 3542, 3612, 3619, 3942, 4101, 4157, 4237, 4242

black stain root disease 921

black-capped chickadee 2324

blackburnian warbler 623, 624, 2656

blackheaded budworm 194, 1416, 1572, 1813, 2940, 3360, 3361

blackthroated green warbler 2656

blue spruce 2-4, 6, 7, 571, 1677, 1841, 2076, 2099, 2101, 3158, 3160, 3162, 3166, 3513, 3651

bluegray gnatcatcher 1817

- Braconidae 2688, 2805
- brain cholinesterase 622, 623, 625, 1315, 1512, 1783, 2280, 2894, 2895
- branch examinations 1838, 2638, 4218
- branch sampling unit 418, 1583-1585, 1724, 2027, 2305, 2381, 2386, 2387, 2452, 2464, 2478, 2599, 2632, 2644, 2674, 2804, 2983, 3401, 3418, 3465, 3477, 3486, 3610, 3869, 4090, 4218, 4221
- branch sizes 1380, 1583, 1585, 3414, 4217, 4218, 4224
- British Columbia 31-34, 54-59, 63-66, 68, 129, 160, 178, 523, 524, 561, 613-617, 672, 673, 721, 817, 825, 826, 829-833, 835, 836, 851-857, 893, 900, 910, 1090-1095, 1100, 1122, 1201, 1215, 1218, 1219, 1304, 1307-1311, 1403, 1522, 1525, 1582-1593, 1615, 1700, 1731-1734, 1737, 1814, 1816, 2002-2005, 2206, 2317-2319, 2328, 2391-2393, 2538, 2584-2589, 2601, 2940, 3102, 3165, 3180, 3182, 3199, 3249, 3329, 3354, 3357-3364, 3366-3370, 3372, 3373, 3389, 3391, 3392, 3632, 3656, 3659, 3662, 3752-3756, 3758, 3792, 3852, 3860, 3961, 3971, 4034, 4075, 4171-4173, 4253-4256, 4261-4272, 4292-4294
- brook trout 1489, 1897, 1953, 2350, 2793
- brownheaded cowbird 2324
- brownspot disease 1554
- browntail moth 2374
- Bruce spanworm 914
- bud mining 169, 276, 518, 896, 1039, 3543
- bud mortality 2538
- bud temperature 4125, 4126
- budbreak 125, 169, 438, 746, 1174, 1176, 2785, 3307, 3371, 3753, 3754, 3758, 3792
- buds 273, 275, 367, 466, 710, 751, 1140, 1141, 1167, 1535, 1724, 1829, 2197, 2376, 2411, 2457, 2538, 2599, 2705, 2867, 3610, 3656, 3663
- butt rots 129, 1393, 1721, 2719, 3020, 3594
- cabbage looper 3556
- caddisflies 3408
- calcium arsenate 190, 336, 338, 3657-3659
- California 602, 922-924, 1297, 1403, 1492, 1892, 1968, 1969, 2043, 2084, 2086, 2570, 2932, 2934, 3311, 3571, 4005, 4056
- cambial electrical capacitance 1290, 2906
- cambial electrical resistance 471, 969, 1290, 2906, 3376, 3379-3381, 3750
- Canada 69, 95, 361, 373, 506, 534-538, 540, 541, 585, 590, 593, 637, 667-670, 674, 676, 686-689, 695, 699, 926, 974, 981, 990, 1106, 1209, 1257, 1416, 1469, 1483, 1515, 1616, 1705, 1774, 1898, 1977, 2001, 2332, 2537, 2711, 2939, 2951, 2982, 3088, 3596-3598
- cannibalism 2383
- Cape May warbler 2666
- Carabidae 1054, 1132, 1409, 1410, 1901, 3032
- carbamates 327, 417, 1303, 1708, 2269, 2363, 2524, 2525, 2737, 2991, 3106, 3109, 3121, 3122, 3135, 3742
- carbaryl 40, 81, 104, 111, 120, 123, 126, 152, 153, 156, 174, 235, 236, 238, 345, 488, 523, 549, 568, 602, 651, 741, 869-872, 890, 987, 992, 1018, 1019, 1042, 1046, 1050, 1051, 1055, 1096, 1126, 1138, 1146, 1150, 1152, 1172, 1173, 1182, 1185, 1275, 1304, 1327, 1347, 1360, 1363, 1458-1464, 1512, 1523, 1524, 1560, 1565-1567, 1594, 1638, 1641, 1644, 1662, 1687, 1688, 1708, 1717, 1745, 1782, 1783, 1786, 1787, 1790, 1808, 1985, 1995,

- 2047, 2082, 2097, 2100, 2114, 2115, 2246,
2250-2252, 2265, 2280, 2285, 2286, 2289,
2290, 2294, 2331, 2333, 2350, 2443, 2444,
2474, 2505, 2519, 2592, 2685, 2696, 2697,
2718, 2766, 2769, 2787, 2793, 2839-2842,
2845, 2913, 2957, 2959, 2964, 2966, 3095,
3106, 3111, 3114, 3124, 3132, 3135, 3139,
3140, 3156, 3157, 3191, 3262, 3274, 3280,
3316, 3344, 3345, 3419, 3420, 3541, 3573,
3623, 3626-3628, 3633, 3636, 3640, 3647-3649,
3694, 3695, 3698-3702, 3801, 3803, 3807,
3809, 3810, 3812-3825, 3842, 3870, 3871,
3898, 3900, 3925, 3926, 3951, 4088, 4249,
4293, 4314, 4318
- carbofuran 1346, 2115
- carbohydrates 2063, 2226
- cartographic history 1575, 3439, 4092
- Central North America 975, 2033, 2433, 2465,
4124, 4216, 4222, 4248
- CGA 13353 3318
- Chalcididae 2372
- chemical control 41, 67, 75, 83, 94, 104, 105, 112,
119, 120, 157, 158, 189, 213, 224, 227, 230,
242, 251, 270, 284, 293, 295, 338, 339, 383,
397-400, 402, 412, 417, 419, 420, 435, 436,
454, 456, 467, 484, 487, 488, 490, 505, 508,
524, 526, 528, 539, 542, 559, 561, 564, 579,
580, 586-589, 594, 595, 598, 605, 619, 635,
641, 642, 679, 680, 684, 685, 694, 703, 712,
716, 757, 763, 779, 815, 838, 847, 864, 880,
956, 971, 976, 981, 987-992, 994, 997, 1014,
1046, 1049, 1054, 1057, 1060, 1063, 1064,
1066, 1096-1099, 1103, 1106, 1107, 1120,
1147, 1185, 1257, 1275, 1279, 1299, 1303-
1306, 1341, 1342, 1344, 1345, 1385, 1416-
1418, 1440, 1455-1457, 1482, 1485-1487, 1490,
1495, 1502, 1508, 1515, 1517, 1526, 1527,
1560, 1564, 1576, 1578, 1597, 1624, 1676,
1691-1693, 1699, 1717, 1720, 1728, 1753,
1801, 1803, 1812, 1882, 1897, 1937, 1945,
1954, 1972, 2036, 2055, 2070, 2083, 2096,
2106, 2148-2150, 2177, 2180, 2181, 2183-2186,
2188-2192, 2197, 2248, 2251, 2266, 2269,
2271, 2272, 2282, 2294, 2338, 2346, 2347,
2352, 2363, 2377, 2379, 2403, 2416, 2442,
2465, 2472, 2474, 2476, 2490, 2497, 2508,
2524, 2526, 2543, 2548, 2549, 2554, 2570,
2625, 2657, 2663, 2676, 2684, 2690, 2706,
2707, 2711, 2727-2737, 2740-2745, 2749-2752,
2764, 2766, 2774, 2775, 2814, 2818, 2819,
2841, 2860, 2894-2896, 2912, 2936, 2942,
2951, 2952, 2961-2963, 2978, 2980, 2982,
2985, 2986, 3048, 3096, 3106, 3109, 3112,
3120, 3124, 3129, 3163, 3177, 3195, 3199,
3259, 3264, 3299, 3320, 3327, 3394, 3406,
3408, 3409, 3419, 3496, 3499, 3534, 3548,
3549, 3567-3569, 3634, 3656, 3658-3661, 3663,
3672, 3681, 3774, 3804, 3863, 3868, 3871,
3900, 3904, 3921, 3931, 3945, 3948, 3952,
3960, 3978, 3981, 3982, 3987, 3988, 3990,
3993, 4008, 4034, 4045, 4050, 4052, 4054,
4064, 4073, 4078, 4080, 4082, 4085, 4091,
4092, 4095, 4098, 4099, 4104, 4109, 4118,
4140, 4152-4154, 4158, 4159, 4182, 4183,
4260, 4273, 4274, 4289, 4302, 4305-4307
- chemical insecticides 153
- chemoreceptors 2528, 3552-3554
- chemosterilants 11, 12, 125, 2811, 3063, 3067,
3076, 3084, 3086, 3088
- chestnut blight 3886
- chipping sparrow 2279, 2324, 3418, 3442
- chitin 223, 1514, 3073, 3083, 3087
- chitinase 582, 588, 986, 993, 1038, 1052, 1053,
1265, 1552, 1729, 2593, 2614, 2739, 3453,
3465, 3471, 3472, 3475-3477, 3485, 3487, 3492
- chlordan 542
- chlorpyrifos-methyl 153
- chlorpyrifos 2286, 3132, 3135

- chlorpyrifos-methyl 979, 1046, 1055, 1726, 2115, 2118, 2287, 2718, 3132, 4318
- cholinesterase 1318, 3492, 3910
- chorions 1839, 2073, 3559
- Christmas trees 120, 191, 356, 397-399, 501, 505, 568, 684, 694, 890, 1008, 1174, 1198, 1199, 2047, 2056, 2100, 2543, 2764, 2788, 3495, 3499, 3513, 3809, 3908, 3945, 4111, 4168
- chromatography 1951
- chromosomes 649, 650, 1204, 1208, 3333, 3505, 3506
- Chrysopidae 3993
- circadian rhythms 818, 2085, 3226, 3251
- clear cutting 266, 278, 442, 452, 473, 1271, 1623, 1834, 1853-1855, 2048, 2860, 3886
- climate 168, 262, 435, 441, 450, 701, 885, 964, 1482, 1502, 1529, 1530, 1535-1539, 1579, 1697, 1816, 1906, 1913, 2130, 2212, 2433, 2457, 2467, 2516, 2658, 2763, 2833, 3297, 3365, 3670, 3965, 4122, 4124, 4129, 4133, 4172
- climatic release 2917, 3185, 4134
- cloud cover 4122, 4125, 4126, 4132, 4136
- Coccinellidae 2197, 3494, 3993
- cold tolerance 1679, 1737
- Coleoptera 317, 320, 400, 539, 613-617
- color morphs 3580, 4004
- color-infrared photography 164, 165, 308, 767
- Colorado 75, 76, 81, 171, 286, 287, 517, 570-573, 607, 630, 631, 756, 890, 925, 996, 1023, 1122, 1480, 1677, 1678, 1862, 2040, 2042, 2047, 2055, 2075, 2098, 2100, 2102, 2103, 2105, 2107, 2109-2111, 2378, 2380-2388, 2434, 2439, 2521, 2522, 2783, 2784, 2967-2971, 3100, 3278, 3602-3604, 3606, 3632, 3646, 3861, 3901, 3902, 4166-4170, 4284-4287
- comandra blister rust 2931
- competition 448, 2093, 2154, 2398, 2656, 2667, 2924, 2945, 3224, 4025, 4047
- computer mapping 512, 513, 842, 843, 1676, 2903, 3194, 3400, 3757
- computer models 802, 1335, 1360, 1401, 3035, 4053, 4179
- computer programs 214, 1129, 2313, 3393, 3394, 3400, 3689, 4050, 4296
- cone damage 294, 1020, 1029, 1031, 1285, 2930, 3016, 3198, 3308, 3346-3348, 3623, 3830, 3831, 4250
- cone insects 129, 1020, 1021, 1027-1031, 1345, 1631, 1649, 2090, 2323, 3007, 3198, 3199, 3346, 3347
- cones 192, 215, 282, 447, 697, 759, 1020-1022, 1027, 1028, 1031, 1285, 1451, 2027, 2029, 2031-2033, 2323, 2402, 2644, 2930, 3028, 3309, 3571, 3627, 3628, 3830, 3831, 4273, 4274
- coneworms 1021, 1027, 1028, 2723, 3346
- Connecticut 525-527
- contact toxicity 542, 2043, 2727-2729, 2731, 2734, 2735, 2737, 2741, 2742, 3120, 3121, 3609
- control 109, 113, 152, 252, 287, 319, 321, 346, 366, 393, 394, 403, 404, 408, 602, 618, 695, 722, 758, 877, 958, 1011, 1012, 1088, 1117, 1229, 1233, 1254, 1334, 1343, 1347, 1415, 1474, 1511, 1543, 1764-1767, 1769, 1868, 1874, 1895, 1924, 1981, 2006, 2023-2025, 2103, 2115, 2133, 2220, 2297, 2306, 2320, 2331, 2348, 2361, 2455, 2520, 2568, 2629, 2801, 2830, 2839, 2845, 2876, 2918, 2936, 2938, 2940, 2941, 2979, 3049, 3176, 3179, 3180, 3260, 3342, 3350, 3352, 3406, 3471, 3524, 3547, 3662, 3783, 3872, 3914, 3964, 3976, 4035, 4036, 4041, 4053, 4104, 4156
- controlled burning 626, 2048, 2419, 2763

- corkbark fir 7, 30, 470, 3162, 3166, 4013
- corky root disease 1257
- cost-benefit analyses 842, 843, 2298, 3264, 3685, 4053, 4179, 4186
- cross breeding 3505, 3506, 3510
- crown classes 299, 1704, 2028, 2030, 2033, 3594, 3853
- crown levels 53, 290, 299, 302, 1086, 1583-1585, 1826, 2030, 2380, 2599, 2632, 2644, 2862, 3656, 3747, 3972, 4181, 4184, 4217, 4218, 4224
- crown measurements 265, 302, 1455, 3365, 3998
- crowns 1673, 1826, 2269, 2380, 2481, 2644, 2675, 2677, 4000, 4176
- Crustacea 3408
- cryolite 2153
- crystal-forming bacteria 1260, 2603, 2621, 3449, 3469, 4290
- cuticle 223, 2803, 2887, 3372, 3559
- cytology 2886, 2887, 3080, 3333, 3521, 3522
- cytoplasmic polyhedrosis viruses 387, 391, 394, 396, 914, 2270, 2612
- Czechoslovakia 643, 699, 1775
- damage 3352
- DDD 1304
- DDE 1476, 1520
- DDT 75-78, 80, 83, 86, 87, 90, 92-94, 100, 108, 109, 111, 112, 116, 120, 121, 123, 130, 153, 193, 201, 224, 239, 270, 271, 277, 321, 325, 327, 336-339, 342, 350, 365, 398, 402, 408, 417, 419, 430, 443, 458, 462, 463, 467, 504, 508, 528, 542, 553, 556, 558, 577, 581, 592, 601, 602, 605, 620, 673, 712, 742, 763, 827, 828, 844, 862, 866, 867, 947, 949, 951, 952, 958, 963, 965-968, 971, 991, 994, 1008, 1034, 1035, 1043, 1048, 1054, 1057, 1058, 1060, 1063-1065, 1069, 1085, 1096, 1097, 1099, 1102, 1115, 1118, 1138, 1147-1149, 1153, 1186, 1187, 1191, 1273, 1275, 1278, 1299, 1301, 1302, 1304, 1306, 1339, 1341, 1343, 1385, 1388, 1413, 1414, 1416-1418, 1436, 1446, 1448, 1476, 1481, 1489, 1496, 1497, 1508, 1519, 1520, 1554, 1594, 1621, 1644, 1708, 1709, 1725, 1727, 1728, 1745, 1753, 1793, 1808, 1812, 1820, 1864, 1869, 1871, 1873, 1876, 1878, 1897, 1919, 1934, 1935, 1939, 1945, 1988, 2028, 2074, 2077, 2096, 2115, 2159, 2167, 2169, 2170, 2172-2176, 2178, 2179, 2181, 2182, 2184-2195, 2197, 2200, 2254-2256, 2259, 2261, 2262, 2264, 2297, 2331, 2336, 2338, 2339, 2342, 2343, 2442, 2449, 2498, 2516, 2568, 2661, 2680, 2681, 2702, 2705-2707, 2712, 2720, 2728, 2729, 2743, 2744, 2773-2775, 2783, 2814, 2834, 2854, 2858, 2937, 2952, 2959, 2984, 2985, 2991, 3029, 3134, 3140, 3209, 3269, 3270, 3299, 3320, 3321, 3374, 3496, 3497, 3525, 3547, 3600, 3610, 3622, 3706, 3707, 3712, 3714, 3717, 3731, 3733, 3776, 3777, 3862, 3868, 3870, 3904, 3922, 3923, 3931, 3952, 3954-3956, 3958, 3979, 3982-3984, 3994, 4010, 4015, 4023, 4031, 4032, 4037, 4045, 4052, 4066-4070, 4072-4076, 4080, 4083, 4084, 4087, 4089, 4096, 4097, 4100, 4140, 4149-4153, 4156, 4158, 4168, 4169, 4273-4275, 4278, 4284, 4292, 4304, 4305, 4309, 4310
- decamethrin 3135
- decay 13, 114, 964, 1291, 2661, 3020, 3379, 3381, 3594, 3595, 3617, 3621
- deer mouse 2639, 2656
- deer yards 26-28, 2925
- defoliation 2-4, 6, 7, 25, 31-34, 41, 50, 52, 54-59, 63-66, 78, 81, 85, 132, 138, 166, 171, 173, 180, 188, 192, 213, 217, 255, 261, 262, 265, 267-

269, 273, 277, 278, 282, 303, 317, 318, 322, 330, 331, 335, 339, 343, 344, 368-371, 393, 400, 403-405, 409-411, 422, 424-426, 431, 432, 448, 451, 454, 456-459, 461, 468, 469, 493, 494, 496, 497, 499-501, 510, 514, 516, 518, 523, 534, 546, 553, 556, 558, 569, 576, 601, 603, 608, 609, 630-633, 637, 662, 669, 672, 673, 681, 684, 691, 692, 709, 710, 713, 716, 719, 724, 735, 737, 754-756, 759, 761, 767, 769, 773-775, 780, 782, 783, 785, 786, 803, 804, 807, 810-814, 851-854, 856, 858-863, 881, 885, 890, 896, 904, 908, 909, 913, 938, 941, 951, 956, 992, 994, 999, 1000, 1002-1004, 1008, 1009, 1016, 1023, 1026, 1037, 1056, 1073, 1075-1077, 1085, 1089, 1092-1094, 1096, 1109, 1114, 1116, 1188, 1192, 1214, 1215, 1241-1243, 1249, 1270, 1285, 1294, 1297, 1300, 1309, 1328, 1334, 1336, 1337, 1341, 1352, 1357, 1361, 1362, 1364-1366, 1373, 1384, 1386, 1412, 1424, 1438, 1439, 1450, 1451, 1467, 1469, 1486, 1492, 1503, 1506, 1509, 1510, 1522, 1531, 1541, 1546, 1558, 1571, 1587, 1592, 1594, 1618-1620, 1625, 1646, 1659, 1661, 1664, 1672, 1674, 1685, 1686, 1720, 1724, 1730, 1732, 1733, 1745, 1761, 1762, 1770, 1825, 1828, 1859, 1865, 1868, 1869, 1871-1873, 1899, 1921, 1922, 1926, 1927, 1929-1938, 1944, 1948, 1960, 1962-1965, 1968-1971, 1983-1986, 1991-1994, 2002, 2004, 2006, 2010, 2026, 2028, 2031-2033, 2040, 2042, 2047, 2049, 2050, 2066, 2076, 2077, 2095, 2097-2103, 2105, 2107, 2109, 2110, 2112-2114, 2117, 2118, 2137-2140, 2154, 2170, 2172, 2173, 2175, 2176, 2187, 2192-2194, 2197, 2211, 2214, 2221, 2230, 2237, 2240, 2247, 2253, 2254, 2256-2264, 2278, 2293, 2302, 2303, 2309, 2310, 2334, 2340, 2341, 2343, 2344, 2353, 2359, 2365, 2368, 2381, 2387, 2401, 2406, 2414, 2422, 2423, 2434-2442, 2449, 2457, 2458, 2463, 2468, 2481, 2497-2500, 2505, 2521, 2522, 2533, 2534, 2548, 2549, 2554, 2559, 2561, 2565, 2574-2581, 2584-2588, 2592, 2599, 2608, 2616, 2618, 2632, 2634, 2636, 2648, 2649, 2652, 2653, 2658, 2672, 2675-2677, 2680, 2682, 2687, 2695, 2699, 2701, 2708, 2719, 2720, 2722, 2753, 2754, 2770-2772, 2777, 2779, 2790, 2798, 2817, 2835-2838, 2840,

2842, 2843, 2877, 2897, 2898, 2905, 2908, 2910, 2911, 2914, 2929, 2941, 2945, 2947, 2955, 2963, 2964, 2966-2970, 2989, 2992, 2997-3000, 3018-3021, 3023, 3025, 3026, 3028, 3031, 3094, 3101, 3145, 3156, 3157, 3159, 3163, 3182, 3196, 3204, 3246, 3260, 3265-3267, 3278, 3292, 3298, 3300, 3308, 3346, 3357, 3369, 3389, 3390, 3392, 3401, 3403, 3406, 3436, 3452, 3463, 3464, 3472, 3483, 3497, 3512, 3514, 3520, 3526, 3528-3530, 3534, 3567, 3587-3589, 3594, 3599, 3610, 3613, 3617, 3622, 3625, 3638, 3647, 3648, 3654, 3658, 3661, 3662, 3674, 3693-3699, 3702, 3706-3709, 3711-3715, 3717, 3718, 3720, 3724, 3726, 3728, 3729, 3732, 3748, 3757, 3770, 3801, 3804, 3808-3813, 3834-3837, 3840, 3841, 3843, 3848, 3849, 3855, 3864, 3869, 3873, 3874, 3889, 3893, 3902, 3908, 3909, 3916, 3940, 3941, 3948, 3961, 3981, 3983, 3985, 3998, 4025, 4028-4032, 4039, 4066, 4067, 4071, 4081, 4083, 4086, 4090, 4091, 4094, 4102, 4109, 4111, 4159, 4165-4167, 4170, 4175, 4181, 4184, 4217, 4218, 4224, 4240, 4244, 4246, 4249, 4261, 4262, 4264-4267, 4270, 4271, 4274, 4313, 4318

defoliators 1891, 2090, 2401, 2653, 2658, 2677, 2940, 4021, 4025

degree-days 288, 306, 313, 1287, 1903, 2088, 2469, 2785, 3338, 3736, 4011

density relationships 2651, 3189

deposits 149-151, 159, 211, 230-238, 240, 500, 733, 764, 913, 914, 965, 1019, 1037, 1051, 1056, 1129, 1182, 1186, 1187, 1212, 1213, 1327, 1468, 1811, 2114, 2173, 2273, 2591, 2592, 2612, 2615, 2616, 2840, 2981, 2987-2990, 2992, 3029, 3196, 3447, 3448, 3451, 3463, 3468, 3477, 3483, 3519, 3525, 3573, 3648, 3701, 3705, 3862, 3891, 3955, 3994, 3995, 4156, 4252, 4295

derris 2153

detection 5, 81, 561, 619, 713, 767, 783, 847, 935, 1008, 1490, 1495, 1511, 1587, 1592, 1649,

- 1661, 1689, 1774, 1812, 1819, 1870, 1981,
2008, 2055, 2074, 2149, 2230, 2441, 2558,
2867, 2893, 3145, 3231, 3232, 3407, 3625,
3684, 3728, 3733, 3773, 3834, 3838, 3893,
3928, 4086, 4111
- development 314, 400, 425, 448, 716, 786, 865,
896, 1440, 1602, 1656, 1859, 2037, 2376, 2466,
2469, 2484, 2798, 2805, 2812, 2816, 3283,
3333, 3336, 3337, 3341, 3669, 3738, 3765,
4101, 4265
- development rate 40, 312, 649, 1168, 1176, 1903,
2187, 3041, 3042, 3358, 3580, 3754, 4001,
4002, 4006
- diapause 288, 1169, 1287, 1605, 1607, 1608,
1614, 1615, 1679, 1737, 2147, 2412, 2413,
2457, 2469, 3041, 3042, 3044, 3083, 3113,
3281, 3358, 3378, 3727, 3736, 4001
- diapause-free development 1599, 1616, 2147,
2413, 2535, 3378
- diatomaceous earth 3593
- diazinon 2788
- dichlorvos 153, 2115, 2975
- dieldrin 153, 528, 1096, 1708, 3320, 3321, 3496
- diflubenzuron 153, 565, 567, 1055, 1479, 1513,
1517, 1518, 1728, 1995, 2993, 3038, 3065,
3066, 3073, 3075, 3077, 3083, 3087, 3089,
3123, 3136, 3137
- dimethoate 153, 399, 409, 684, 727, 987, 992,
1031, 1306, 1385, 1717, 2077, 2106, 2115,
2167, 2498, 2980, 2991, 3007, 3015, 3495, 3925
- Diptera 53, 302, 539, 613, 617, 829-831, 835, 836,
1066, 1074, 1087, 1118, 1125, 1655, 1735,
1736, 1739, 1859, 2012, 2070, 2328, 2443,
2961, 3181, 3375, 3405
- diseases 387, 1122, 1184, 1314, 1331, 1333, 2457,
2489, 2713-2715, 2890, 2950, 3174, 3365,
3446, 3470, 3560, 3565, 3687, 3768, 3972, 4196
- dispersal 445, 777, 1280, 1351, 1669, 2390-2392,
2657, 2660, 2941, 3178, 3440, 3583, 4124
- distribution 182, 284, 295, 347, 534, 536-538,
543, 561, 669, 674, 686, 695, 716, 820, 975,
990, 1395, 1403, 1407, 1408, 1608, 1718, 1821,
1895, 2817, 2922, 2932, 3170, 3238, 3259,
3271, 3302, 3586, 3655, 3689, 4091, 4154, 4235
- diurnal rhythms 1155, 3213, 3251
- dosage 144, 157, 158, 193, 211, 270, 325, 400,
415, 417, 420, 487, 488, 518, 528, 553, 568,
578, 584-586, 589, 590, 593, 594, 605, 757,
909, 911, 913, 951, 968, 991, 1046, 1060, 1064,
1088, 1097, 1099, 1147-1149, 1179, 1299,
1304, 1305, 1315, 1341, 1342, 1543, 1692,
1728, 1730, 1770, 1783, 1801, 1878, 1891,
1938, 1939, 1967, 2022, 2046, 2074, 2197,
2269, 2274, 2283, 2289, 2346, 2347, 2352,
2363, 2474, 2476, 2504, 2505, 2508, 2524,
2593, 2597, 2599, 2600, 2605, 2607-2609,
2611, 2613, 2702, 2705, 2743, 2775, 2805,
2809, 2814, 2852, 2895, 2896, 2961, 2982,
2986, 3038, 3068, 3078, 3083, 3085, 3097,
3109, 3110, 3129, 3140, 3313, 3321, 3408,
3461, 3487, 3504, 3569, 3609, 3610, 3636,
3640, 3656, 3659, 3660, 3663, 3682, 3691,
3767, 3803, 3827, 3868, 3887, 3972, 3983,
3990, 3992, 4037, 4073, 4074, 4081, 4083,
4085, 4152, 4153, 4191, 4306
- dosage-mortality studies 542, 577, 600, 1147,
1267, 1377, 1413, 1448, 1730, 1878, 2022,
2046, 2253, 2269, 2592, 2617, 2620, 2623,
2705, 2727, 2989, 3039, 3068, 3114, 3116-
3118, 3121, 3125, 3129, 3131, 3136, 3138,
3140, 3269, 3270, 3313, 3319, 3334, 3633,
3640, 3862, 3870, 3972, 4188
- Douglas-fir 2-4, 6, 7, 13, 31-34, 171, 180, 195,
230, 286, 313, 314, 343, 344, 369, 370, 470,
493, 494, 501, 517, 523, 562, 570, 571, 602,
608, 609, 632, 655-657, 666, 701, 702, 704,
705, 717, 718, 745-747, 756, 759, 760, 765,
817, 857, 893, 934, 966, 967, 996, 1020-1022,
1028-1031, 1090, 1108, 1157, 1250, 1256,
1284, 1412, 1475, 1498, 1518, 1541, 1551,

- 1563, 1583, 1586, 1589-1591, 1641, 1677, 1678, 1700, 1707, 1711, 1753, 1861, 1870, 1903, 1960, 1961, 1963-1965, 1968, 2002, 2004, 2005, 2042, 2076, 2077, 2086, 2096, 2098, 2099, 2101, 2102, 2116, 2152, 2209, 2282, 2284, 2293, 2296, 2299, 2321, 2353-2355, 2357, 2364, 2366, 2381, 2391, 2393, 2432, 2434, 2439, 2687, 2696, 2722, 2773, 2784, 2838, 2839, 2841, 2922, 2968-2970, 3007, 3010, 3014-3017, 3062, 3100, 3122, 3139, 3158-3160, 3162, 3166, 3180, 3182, 3198, 3205, 3266, 3275-3279, 3290, 3323, 3344, 3347-3349, 3357, 3371, 3390, 3513, 3539, 3551, 3587-3590, 3622-3625, 3628, 3630, 3644, 3645, 3676-3679, 3685, 3697, 3706, 3709, 3711, 3718, 3719, 3722, 3729, 3753-3755, 3757-3759, 3787, 3835, 3840, 3841, 3843, 3848, 3859, 3870, 3904, 3945, 3970, 3971, 4002, 4005, 4007, 4012, 4166, 4167, 4177, 4268-4272, 4280
- Douglas-fir beetle 129, 524, 805, 1678, 2116, 2441, 2893, 3534, 3921, 3922
- Douglas-fir cone gall midge 524
- Douglas-fir cone moth 524, 1027-1029
- Douglas-fir needle blight 1870
- Douglas-fir scale midge 1021, 1027
- Douglas-fir seed chalcid 1027
- Douglas-fir tussock moth 129, 194, 363, 608, 690, 768, 921, 934, 936, 1360, 1416, 1479, 1518, 1554, 1580, 1581, 1644, 1660, 1995, 2116, 2285, 2410, 2623, 2993, 3124, 3330, 3357, 3634, 3640, 3645, 3749, 3921, 4177, 4178, 4293
- dragonflies 1953, 2104
- drainages 4181, 4182
- drop cloths 2644, 2674, 2937, 3982, 4084, 4215
- dusky flycatcher 2279
- Dutch elm disease 1257, 1554, 2410, 2560, 3048
- dwarf mistletoe 129, 524, 1108, 1257, 2056, 2560, 3162, 3602
- earthworms 1054, 1063
- eastern blackheaded budworm 556, 750, 1815, 2949
- Eastern Canada 41, 154, 176, 178, 192, 434, 452, 467, 544, 693, 696, 973, 1116, 1388, 1634, 1636, 1880, 1943, 1945, 2254, 2255, 2260, 2261, 2263, 2264, 2330, 2473, 2818, 3246, 3498, 3513, 3657, 3662, 3666, 3667, 4076
- eastern hemlock 473, 514, 1361, 1394, 1564, 1841, 2509, 3062, 3176, 3537, 3538, 3674
- eastern hemlock looper 914, 2374, 2561, 3619
- Eastern North America 145, 415, 420, 677-679, 1544, 1595, 1745, 1803, 1922, 1923, 2023-2025, 2090, 2465, 2512, 4064, 4124, 4142, 4143, 4299
- eastern tent caterpillar 2062, 2064
- Eastern United States 293, 2020, 3885, 3886
- eastern white pine 473, 1394, 1657, 1744, 1841, 2345, 2518, 3062, 3255, 4309
- ecdysone 12, 2037
- economics 50, 78, 83, 84, 109, 116, 117, 119, 120, 125, 139, 170, 175, 224, 251, 252, 257, 262, 366, 372, 373, 398, 402, 411, 415, 446, 459, 512, 528, 626, 639, 680, 723, 726, 727, 733, 758, 763, 778, 810, 814, 819, 840, 885, 995, 1008, 1096, 1133, 1134, 1146, 1192, 1196, 1225, 1233, 1236, 1237, 1241-1243, 1246, 1247, 1253, 1255, 1258, 1312, 1313, 1341, 1342, 1387, 1401, 1414, 1428, 1441, 1442, 1455, 1474, 1482, 1486, 1495, 1504, 1509, 1543, 1594, 1628, 1631, 1632, 1634, 1648, 1701, 1721, 1743, 1745, 1754, 1779, 1799, 1801, 1803-1806, 1820, 1878, 1882, 1896, 1912, 1939, 1977, 1987, 2047, 2074, 2097, 2100, 2128, 2167, 2181, 2246, 2248, 2265,

2298, 2305, 2312, 2313, 2337-2339, 2366,
2409, 2457, 2477, 2482, 2489, 2492, 2498,
2514, 2516, 2520, 2548, 2554, 2590, 2600,
2650, 2672, 2684, 2685, 2690, 2692, 2703,
2704, 2709, 2720, 2745, 2749-2752, 2755,
2759, 2761, 2766, 2818, 2831, 2832, 2871,
2923, 2926-2928, 2936, 2941, 3001, 3029,
3073, 3178, 3179, 3194, 3195, 3218, 3264,
3324, 3342, 3426, 3427, 3430, 3525, 3534,
3547, 3548, 3599, 3659, 3663, 3667, 3673,
3675, 3685, 3701, 3705, 3730, 3831, 3838,
3857, 3863, 3870, 3895, 3896, 3900, 3911,
3914, 3922, 3923, 3948, 3955, 3956, 3976,
3998, 4010, 4045, 4050, 4053, 4054, 4071,
4079-4081, 4095, 4104, 4149, 4150, 4153,
4156, 4160, 4186, 4238-4240, 4250, 4289

ecosystems 698, 2325, 2332, 2924

efficacy 50, 62, 67, 80, 97, 108, 116, 151, 157,
158, 171, 193, 212, 229, 234, 270, 271, 296,
304, 305, 307, 310, 324-328, 345, 393, 394,
404, 408, 410, 412, 414, 419, 436, 455, 457,
459, 500, 553, 565, 568, 577, 601, 628, 629,
637, 651, 723, 726, 727, 731-736, 739, 757,
763, 782, 808, 809, 815, 822, 862, 864, 865,
900, 905, 906, 908-911, 913, 938, 947, 949,
951, 965, 967, 968, 979, 980, 982-987, 991,
992, 994, 1011, 1012, 1031, 1037, 1038, 1040-
1042, 1044, 1046, 1050-1053, 1055, 1056,
1060, 1061, 1070, 1088, 1099, 1112, 1128,
1146-1149, 1191, 1210, 1240-1243, 1263, 1267,
1275, 1327, 1329, 1347, 1360, 1363, 1413,
1479, 1513, 1516, 1517, 1543, 1639, 1687,
1688, 1690, 1693, 1700, 1724, 1726, 1728-
1730, 1760, 1770, 1801, 1807, 1861, 1871,
1890, 1917, 1924, 1925, 1935, 1938, 1941,
1945, 1947, 1948, 1966, 1967, 1984, 1995,
2010, 2018, 2022, 2050, 2077, 2079, 2108,
2114, 2124, 2129, 2153, 2170, 2171, 2173,
2175, 2176, 2193, 2194, 2251, 2255, 2256,
2259, 2261, 2262, 2264, 2272, 2281, 2283,
2284, 2286-2288, 2290, 2291, 2294, 2295,
2338, 2339, 2346-2349, 2422, 2423, 2476,
2488, 2492, 2504, 2505, 2507, 2508, 2590,
2591, 2593-2595, 2597-2600, 2602, 2603, 2608-
2617, 2619, 2621, 2622, 2626, 2680, 2681,
2686, 2706, 2728, 2729, 2733, 2734, 2742,

2746, 2749-2752, 2756, 2775, 2788, 2839-2842,
2845, 2847, 2875, 2907, 2965, 2980, 2989,
2992, 3005, 3007, 3008, 3010-3012, 3014-3016,
3029, 3066, 3070, 3075-3077, 3083, 3084,
3089, 3098-3100, 3112, 3115, 3119, 3124,
3127, 3128, 3134, 3148, 3161, 3196, 3286,
3288, 3299, 3304, 3314, 3315, 3319, 3321,
3342, 3344, 3368, 3394, 3403, 3408, 3409,
3449, 3450, 3452, 3455-3457, 3461, 3463-3465,
3469, 3471, 3473, 3475, 3477, 3483, 3485,
3487, 3489, 3496, 3507, 3511, 3516, 3517,
3532, 3540, 3547, 3548, 3568, 3578, 3592,
3609, 3610, 3623, 3624, 3627, 3629-3631,
3648, 3649, 3658, 3700, 3701, 3705, 3730,
3742, 3749, 3801, 3803, 3806, 3809, 3814,
3815, 3862, 3863, 3870, 3871, 3881, 3891,
3895, 3896, 3909, 3910, 3923, 3931, 3955,
3956, 3995, 4022, 4037, 4066-4071, 4073,
4074, 4077, 4079-4081, 4087, 4097-4099, 4149-
4151, 4156, 4177, 4182, 4187, 4189, 4212,
4284, 4286, 4318

egg age 2810, 3522

egg density 1336, 1688, 1854, 2073, 2452, 2472,
2643, 2874, 2947, 3256, 3768, 4033

egg development 425, 1656, 3041

egg masses 5, 400, 646, 666, 896, 1078, 1146,
1164, 1170, 1241-1243, 1379, 1536, 1539,
1546, 1547, 1583, 1584, 1588, 1838, 1839,
1859, 1916, 1945, 2029, 2033, 2073, 2311,
2365, 2382, 2386, 2452, 2466, 2472, 2474,
2482, 2495, 2502, 2503, 2630, 2638, 2874,
3043, 3068, 3086, 3204, 3392, 3402, 3569,
3843, 3854, 3858, 3887, 4033, 4217, 4221, 4224

egg morphology 646

egg mortality 425, 2455, 2716, 2810

egg parasites 5, 728, 1399, 1589, 1741, 1747,
1748, 1751, 1850, 2051, 2185, 2421, 2454,
2455, 2609, 2706, 2825, 3392, 3747, 3767,
3787, 4170

egg parasitism 1089, 3392

- egg populations 709, 1578, 1688, 2452, 2643, 2677, 3569
- egg predators 1840, 1852, 2126, 2185
- egg size 649, 650, 1602
- egg survival 2185, 2645, 2716, 3041, 3767
- egg viability 2593, 2612, 2809
- egg weight 650, 1598, 1600-1602
- egg-mass age 2648, 3858
- egg-mass density 2-4, 6, 120, 213, 307, 439, 457, 459, 461, 466, 545, 551, 569, 608, 609, 630, 631, 681, 709, 710, 755-757, 783, 812, 851, 858-863, 938, 951, 1073, 1078, 1089, 1300, 1328, 1334, 1378, 1381, 1382, 1506, 1761, 1762, 1850, 1938, 1945, 1960, 1961, 1964, 1965, 1985, 2042, 2073, 2076, 2097, 2099, 2101, 2105, 2107, 2109, 2110, 2170, 2172, 2173, 2175, 2176, 2193, 2194, 2251, 2253, 2254, 2264, 2344, 2386, 2434, 2470, 2472, 2473, 2495, 2502, 2503, 2521, 2522, 2608, 2613, 2638, 2660, 2835, 2840, 2842, 2898, 2914, 2963, 2964, 2966, 2989, 3026, 3156, 3157, 3159, 3163, 3182, 3392, 3402, 3406, 3415, 3437, 3569, 3588, 3631, 3693-3696, 3698, 3699, 3702, 3706-3709, 3711-3715, 3718, 3808-3812, 3836, 3837, 3902, 4029, 4031, 4032, 4090, 4093, 4166, 4167, 4221
- egg-mass sampling 5-7, 50, 63, 173, 268, 283, 343, 344, 454, 457-459, 461, 545, 551, 569, 570, 601, 604, 632, 633, 657, 681, 708, 739, 752, 756, 783, 785, 786, 852, 858, 861-864, 890, 896, 922-924, 948, 1016, 1077-1079, 1109, 1116, 1170, 1300, 1328, 1348, 1351, 1357, 1365, 1378-1382, 1384, 1546, 1558, 1578, 1583, 1588, 1590, 1620, 1780, 1831, 1836, 1838, 1842, 1929-1933, 1938, 1940, 1944, 1961, 1986, 2002, 2005, 2006, 2040, 2042, 2047, 2073, 2076, 2098, 2100, 2102, 2103, 2109, 2110, 2112-2114, 2168, 2240, 2302, 2303, 2308, 2309, 2311, 2377, 2381, 2382, 2386, 2387, 2435-2440, 2453, 2472, 2476, 2482, 2499, 2500, 2502, 2503, 2521, 2522, 2549, 2559, 2565, 2574, 2576, 2577, 2580, 2608, 2630, 2638, 2648, 2674, 2795, 2804, 2842, 2897, 2898, 2924, 2966-2970, 3024, 3026, 3031, 3145, 3158, 3160, 3163, 3204, 3246, 3278, 3397, 3403, 3414-3417, 3530, 3551, 3587, 3625, 3648, 3714, 3724, 3729, 3732, 3770, 3807, 3809, 3841, 3843, 3849, 3854, 3858, 3875, 3899, 3902, 3935, 3941, 4035, 4036, 4041, 4043, 4090, 4093, 4094, 4170, 4217, 4218, 4261, 4270, 4271
- egg-mass size 298, 666, 1602, 2382, 3747, 4033
- eggs 298, 425, 896, 1078, 1296, 1351, 1420, 1437, 1440, 1447, 1530, 1535, 1536, 1547, 1578, 1584, 1588, 1598, 1601, 1602, 1610, 1656, 1689, 1828, 1829, 1839, 1859, 1940, 1945, 2057, 2073, 2184, 2368, 2382, 2413, 2457, 2466, 2482, 2489, 2613, 2638, 2645, 2677, 2714, 2802, 2803, 2806, 2809, 2810, 2947, 3068, 3072, 3086, 3088, 3250, 3256, 3333, 3505, 3506, 3521, 3522, 3552, 3559, 3610, 3656, 3764, 3767, 3768
- EL 1215 3075
- EL 127063 3137
- EL 494 3066, 3073, 3075
- EL 7063 3075
- EL 7961 3075
- electroantennograms 22, 23, 88, 2820, 2822-2824, 3183, 3258, 3387, 4065
- electron microscopy 23, 1637
- elevation 2317, 3358, 3441, 3727, 3754, 3756, 4011
- elm leaf beetle 1892
- embryonic development 2806, 2810, 3068, 3072, 3088, 3559, 3565
- EMC 33297 1728

- endemic populations 1122, 1192, 1420, 1423, 1915, 1919, 2181, 2197, 2455, 2467, 2479, 2482, 2483, 2486, 2647, 2652, 2656, 2917, 3046, 3185, 3222, 3251, 3261, 3365, 3561, 3981, 4064, 4134, 4153
- endosulfan 336
- endrin 3320, 3321
- Engelmann spruce 2-4, 6, 7, 30, 180, 314, 343, 344, 369, 370, 470, 765, 893, 1498, 1960, 1968, 2076, 2098, 2099, 2209, 2321, 2364, 2366, 2393, 2967, 3158, 3160, 3162, 3166, 3625, 3644, 3835, 3840, 3848, 4013
- English yew 3062
- entomopox viruses 140, 143, 377, 379, 384, 392, 393, 395, 595, 600, 612, 637, 902-904, 911, 914, 1215, 1760, 1770, 1887, 2045, 2598, 2600, 2603, 2612, 2613
- environment 242, 776, 824, 975, 1495, 1511, 1605, 1615, 1713, 1817, 1818, 1981, 2179, 2377, 2797, 2982, 3354, 3370, 3424, 3611, 3982
- environmental impact statements 3264, 3877-3880, 3882-3884, 3903, 3905, 3917, 3949, 3950
- environmental impacts 10, 584-590, 592, 593, 595, 596, 598, 600, 622, 623, 723, 763, 827, 872, 1043, 1048, 1054, 1063, 1065, 1066, 1118, 1148, 1158, 1166, 1277, 1278, 1299, 1301, 1302, 1304, 1315, 1318, 1377, 1409, 1410, 1446, 1448, 1458-1460, 1464, 1476, 1482, 1512, 1520, 1559, 1565, 1566, 1621, 1658, 1692, 1724, 1783, 1790, 1809, 1863, 1878, 1897, 1953, 1955, 1958, 1972, 1988, 2070, 2074, 2106, 2178-2181, 2185-2188, 2190-2192, 2197, 2280, 2330, 2331, 2403, 2416, 2490, 2505, 2599, 2610, 2613, 2622, 2696, 2697, 2702, 2706, 2737, 2740, 2743, 2768, 2787, 2804, 2814, 2856, 2857, 2890, 2894-2896, 2912, 2961, 2962, 3073, 3096, 3197, 3318, 3405, 3408, 3420, 3549, 3567, 3647, 3681, 3682, 3799, 3813, 3816, 3817, 3820, 3826, 3978, 3981-3984, 3987, 3990, 3992, 3993, 4073, 4074, 4080, 4083, 4099, 4160, 4161, 4182, 4183, 4258, 4260, 4273, 4274, 4306, 4307
- environmental monitoring 742, 1917, 2416, 2767, 3647, 3813, 3826, 3978
- environmental quality 1977, 3978, 4064
- Ephemeroptera 870, 1166, 2961, 2962, 3821
- epicenters 420, 1104, 1192, 1573-1575, 1579, 2465, 2489, 3234, 3259, 3583, 3969, 3987
- epidemic populations 397, 435, 1118, 1122, 1125, 1192, 1308, 1420, 1891, 1915, 1919, 1920, 2065, 2066, 2074, 2156, 2181, 2197, 2454, 2457, 2459, 2465, 2479, 2486, 2489, 2490, 2566, 2635, 2647, 2652, 2656, 2658, 2667, 2677, 2764, 2817, 2866, 2873, 2890, 2917, 2941-2943, 2945, 2954, 3026, 3027, 3030, 3047, 3170-3173, 3189, 3204, 3251, 3259-3261, 3298, 3365, 3442, 3471, 3561, 3583, 3593, 3594, 3599, 3617, 3621, 3662, 3665, 3670, 3673, 3674, 3747, 3748, 3792, 3793, 3796, 3969, 3981, 3987, 4039, 4073, 4074, 4077, 4080, 4083, 4092, 4099, 4105, 4122, 4132, 4134, 4142, 4152, 4153, 4175, 4184, 4274, 4312, 4317
- epizootiology 1609, 1891, 2889, 3972
- Europe 575, 699, 1885, 2512, 3307
- European fir budworm 575, 699, 931, 1428, 2513, 3164, 3307, 4315
- European larch 1744
- European pine sawfly 336, 914, 1121, 2374, 2885
- European pine shoot moth 934, 935, 2062, 2064, 2374
- European spruce sawfly 441, 690, 914, 971, 1184, 1257, 1485, 2056, 2332, 2374
- evaluation 6, 166, 322, 485, 501, 756, 763, 785, 815, 847, 1007, 1015, 1020, 1027, 1028, 1108, 1109, 1214, 1364, 1423, 1439, 1495, 1511, 1546, 1558, 1587, 1592, 1711, 1713, 1874, 1961, 1981, 1991-1994, 2013, 2042, 2047, 2074, 2112, 2117, 2118, 2149, 2238, 2311, 2344, 2434, 2439, 2497, 2534, 2558, 3145, 3715, 3732, 3733, 3770, 3783, 3834, 3863, 3893, 4111, 4166, 4167

- evaporation rates 3355, 3356, 3365, 3372, 4127, 4128, 4131, 4133, 4135
 evening grosbeak 2279, 3685
 evolution 1650, 3581, 4315
 exclusion cages 652, 702, 1400, 2467, 3221, 3788
 eye color 3082, 3585
 fall cankerworm 553, 1581
 fall webworm 2631
 false hemlock looper 3360, 3361
 fats 1736, 3340
 fatty acids 67, 1131, 1739, 3388
 fecundity 40, 282, 424, 448, 466, 517, 649, 650, 896, 940, 953, 1349, 1437, 1529, 1530, 1536, 1538, 1602, 1610, 1828, 1829, 1875, 1940, 2064, 2069, 2123, 2184, 2186, 2322, 2384, 2411, 2452, 2458, 2484, 2489, 2536, 2634, 2645, 2657, 2661, 2679, 2714, 2802, 2803, 2809, 3035, 3097, 3103, 3126, 3228, 3305, 3505, 3562, 3580, 3742, 3745, 3767, 4193, 4202, 4209
 feeding 17, 42, 85, 96, 122, 165, 166, 169, 195, 209, 273, 275, 284, 294, 367, 368, 400, 424, 425, 438, 448, 466, 469, 650, 881, 896, 953, 1140, 1141, 1147, 1169, 1266, 1281-1283, 1285, 1312, 1440, 1469, 1509, 1514, 1531, 1538, 1547, 1564, 1585, 1616, 1733, 1828, 1829, 1951, 2027, 2029, 2031, 2033, 2034, 2057, 2067, 2069, 2325, 2352, 2413, 2450, 2452, 2457, 2461, 2475, 2489, 2593, 2629, 2635, 2643, 2666, 2676, 2677, 2705, 2867, 2930, 3079, 3090, 3204, 3294, 3298, 3335, 3408, 3465, 3472, 3505, 3586, 3610, 3656, 3658, 3663, 3673, 3764, 3830, 4081, 4105, 4125, 4129, 4131, 4134, 4202
 feeding behavior 17, 19, 20, 1656, 1675, 2081
 feeding deterrents 18, 20, 39, 351-355, 837, 899, 1345, 1675, 2265, 2593, 3017, 3359, 3650, 3651, 4290
 feeding inhibition 1268, 3090
 feeding shelters 1469, 2705, 3107, 4125
 feeding stimulants 15, 18, 19, 1675
 feeding-shelter temperature 4125
 female moths 2658, 3082, 3088, 3215, 3216, 3224, 3250-3252, 3256, 3406, 3510, 3552-3554, 3580, 3582, 3742, 3764, 3767, 4057, 4061, 4129, 4219-4221
 female reproductive system 2803, 2806
 fenitrothion 40, 104, 120, 150, 152, 156, 181, 296, 297, 304, 336, 488, 490, 508, 509, 532, 548, 550, 578, 581, 584, 587-589, 592, 595-597, 624, 625, 731, 737-740, 757, 800, 801, 858, 863-865, 876, 991, 992, 994, 1009-1012, 1036, 1046, 1052, 1066, 1070, 1096, 1115, 1126, 1138, 1153, 1159-1161, 1163, 1165, 1166, 1172, 1173, 1178, 1179, 1211, 1212, 1216, 1301, 1302, 1315, 1326, 1347, 1465, 1556, 1560, 1597, 1622, 1641, 1662, 1663, 1687, 1688, 1715, 1716, 1726, 1728, 1730, 1745, 1760, 1771, 1808, 1863, 1925, 1934, 1935, 1937-1939, 1944, 1945, 1948, 1949, 1952, 1953, 1956, 2010, 2022, 2071, 2167, 2176, 2195, 2199, 2200, 2276, 2277, 2280, 2331, 2394, 2400, 2403, 2415, 2418, 2488, 2491, 2520, 2592, 2598, 2600, 2605, 2608, 2609, 2612, 2613, 2625, 2686, 2709, 2710, 2712, 2718, 2732, 2736, 2740, 2743, 2744, 2746, 2800, 2845, 2852, 2853, 2855-2857, 2883, 2894-2896, 2919-2921, 2952, 2959, 2961, 2962, 2987, 2989, 2991, 2992, 3096, 3098, 3104, 3124, 3135, 3197, 3209, 3334, 3345, 3405, 3462, 3478, 3545, 3546, 3549, 3600, 3647, 3649, 3680-3682, 3734, 3774, 3777, 3799, 3910, 3925, 3978, 3980, 3982-3985, 3987-3989, 3993, 3994, 4000, 4010, 4026, 4088, 4257-4260, 4292, 4306-4308, 4311, 4317
 fenthion 153

- fenvalerate 3135, 3136
- fertility 1610, 2044, 2122, 2714, 2802, 3126, 3580
- fertilized trees 918, 919, 1198, 1717, 2247, 2832, 3208, 3293, 3336, 3339, 3341, 3351, 3353, 3915, 3962
- filament bearer 2282
- fir engraver 363, 805, 1580, 2116, 2893
- fir needle miner 3534
- fire 29, 79, 84, 117, 120, 435, 452, 456, 703, 1209, 1257, 1274, 1276, 1342, 1419, 1469, 1499, 1502, 1551, 1554, 1657, 1712, 1950, 2056, 2057, 2246, 2299, 2351, 2399, 2661, 2689, 2748, 2763, 2871, 2890, 2999, 3195, 3263, 3324, 3641, 3667, 3673, 3674, 3965, 4110
- fire danger 2708
- fire hazard 170, 1376, 1419, 2890, 3641, 3674, 4250
- fishes 111, 490, 556, 581, 588, 589, 593, 742, 800, 827, 828, 837, 844, 901, 1007, 1043, 1115, 1127, 1173, 1299, 1304, 1339, 1446, 1471, 1476, 1783, 1791, 1793, 1897, 1953, 2015, 2106, 2172, 2199, 2265, 2280, 2350, 2505, 2707, 2709, 2737, 2740, 2774, 2775, 2847, 2883, 2936, 2942, 2952, 2958, 2960, 2986, 3408, 3681, 3682, 3910, 3984, 3987, 4023, 4074, 4083, 4156
- flakeboard 1449, 1781
- flight behavior 1155, 1280, 1528, 1530, 1533, 1534, 1536, 1540, 1668, 1670, 1689, 2180, 2972, 3225, 3250, 3256, 3360, 3361, 3395, 3421, 4123, 4129, 4133
- Florida 230
- flowering 448, 451, 1450, 1451, 1538, 1951, 2643, 2649, 2930, 3308, 3354, 3364
- fluorescent particles 1691-1693, 2043, 4000
- fluorides 700
- foliage 227, 231, 232, 241, 424, 466, 1115, 1349, 1604, 1914, 1951, 1971, 2034, 2046, 2067, 2069, 2084, 2195, 2278, 2381, 2386, 2402, 2403, 2450, 2472, 2478, 2481, 2482, 2505, 2596, 2618, 2632, 2634, 2636, 2638, 2909, 2913, 2980, 3096, 3279, 3294, 3321, 3335, 3339, 3340, 3390, 3401, 3402, 3465, 3469, 3609, 3621, 3656, 3658, 3830, 3994, 4078, 4119, 4120, 4125, 4126
- foliage age 424, 425, 448, 1951, 2029, 2452, 2581, 3340, 4025
- foliage analyses 1914, 2636, 2909
- foliage production 1646, 1647, 2461, 2649
- foliage protection 157, 212, 213, 252, 410, 414, 417, 450, 459, 500, 518, 522, 568, 637, 757, 988, 991, 992, 994, 1036, 1038, 1044, 1052, 1114, 1116, 1302, 1341, 1688, 1770, 1801, 1937, 1938, 1944, 1984, 2022, 2028, 2179, 2197, 2251, 2505, 2593, 2599, 2607-2610, 2613, 2755, 2804, 2992, 3073, 3100, 3403, 3408, 3461, 3471, 3477, 3486, 3487, 3567, 3626, 3628, 3647, 3749, 3976, 4022, 4077, 4078, 4081, 4084, 4085, 4090, 4152, 4274
- foliage residues 589, 4306
- foliar nutrients 517, 917, 919, 2327, 2556, 2911, 3146, 3336, 3337, 3339, 3340
- food assimilation 3766, 3767
- food consumption 39, 311, 470, 1959, 2536, 2557, 3079, 3739, 4013
- food preferences 15, 18, 195, 1142, 1403, 1408, 1437, 1775, 1828, 2355, 3308, 3830, 3958
- food quality 15, 19, 39, 314, 355, 424, 438, 448, 466, 470, 517, 745-747, 812, 1332, 1335, 1530, 1535, 1673, 1738, 1951, 2000, 2067, 2069, 2186, 2187, 2190-2192, 2321, 2327, 2356, 2384, 2393, 2449, 2452, 2484, 2555-2557, 2794, 2798, 2848, 3017, 3146, 3293, 3305, 3339, 3340, 3371, 3688, 3739, 4012, 4013, 4101, 4245

food quantity 1530, 2186, 2187, 2190-2192, 2384,
2449, 2458, 2555, 2634, 2714, 2794, 2798

food requirements 650, 1603, 1604, 3335

food supply 256, 1509, 1891, 2384, 2388, 2660,
2677, 3656, 3792, 3796, 3984, 4080

forecasts 3, 4, 6, 7, 54-59, 63-66, 180, 188, 261,
303, 322, 343, 344, 403-405, 431, 439, 461,
523, 545, 564, 569, 604, 608, 609, 630-633,
674, 681, 686, 707, 710, 721, 739, 755, 756,
763, 773, 782, 783, 785, 786, 851-854, 856,
858, 860, 862, 864, 890, 893, 1002, 1013, 1023,
1076, 1077, 1092-1094, 1109, 1154, 1215,
1242, 1300, 1309, 1328, 1351, 1357-1359,
1361, 1366, 1384, 1428, 1522, 1546, 1558,
1571, 1578, 1620, 1711, 1758, 1759, 1761-
1769, 1773, 1871, 1880, 1926, 1927, 1929,
1931, 1934, 1935, 1938, 1944, 1946, 1948,
1960-1965, 1968, 1969, 1985, 1986, 1991-1994,
2013, 2023-2025, 2040, 2042, 2047, 2074,
2097-2100, 2102, 2105, 2107, 2109, 2110,
2112, 2113, 2117, 2118, 2170, 2172, 2173,
2175, 2176, 2183, 2193, 2232, 2236-2240,
2253, 2255-2264, 2302, 2305, 2306, 2308,
2309, 2422, 2423, 2434-2440, 2452, 2469,
2473, 2483, 2497-2500, 2521, 2522, 2558,
2559, 2562, 2565, 2574-2580, 2584-2588, 2608,
2629, 2640, 2687, 2692, 2835-2838, 2841,
2843, 2869, 2874, 2897, 2898, 2914, 2936,
2947, 2954, 2963, 2964, 2967-2970, 2998,
2999, 3026, 3031, 3145, 3156-3158, 3160,
3163, 3178, 3182, 3204, 3260, 3278, 3325,
3328, 3369, 3404, 3436, 3437, 3514, 3568,
3599, 3613, 3625, 3647, 3649, 3681, 3693,
3695, 3696, 3706-3708, 3711, 3714, 3715,
3728, 3770, 3792, 3808-3815, 3834, 3835,
3840, 3841, 3843, 3848, 3849, 3864, 3873,
3874, 3893, 3902, 3934, 3948, 4010, 4011,
4029, 4031-4033, 4068, 4085, 4090, 4134,
4152, 4159, 4166, 4167, 4170, 4262, 4264,
4266, 4267

forest diseases 54-59, 64-66, 246, 714, 780, 783,
786, 851-854, 856, 1092-1094, 1109, 1202,
1215, 1220, 1257, 1274, 1309, 1375, 1522,
1550, 1558, 1701-1703, 1719, 1721, 1821,

1824, 1896, 1969, 2047, 2118, 2236, 2237,
2240, 2245, 2307, 2493, 2537, 2578, 2584-
2588, 2661, 2698, 2701, 3145, 3199, 3297,
3441, 3499, 3770, 3783, 3838, 3906, 3961,
4026, 4111, 4251, 4262, 4264-4267, 4272

forest insects 54-59, 63-66, 71, 182, 211, 225,
242, 338, 347, 484, 505, 614-617, 667, 780,
783, 785, 786, 803, 804, 806, 828, 851-856,
877, 1021, 1028, 1091-1094, 1109, 1198, 1215,
1218-1220, 1223-1225, 1228-1239, 1244-1249,
1251-1253, 1257, 1274, 1288, 1303, 1306,
1309, 1375, 1385, 1409, 1410, 1417, 1444,
1507, 1508, 1522, 1550, 1558, 1621, 1701-
1703, 1719, 1774, 1783, 1812, 1817, 1818,
1821, 1865-1868, 1895, 1896, 1969, 1981,
1991-1994, 2036, 2047, 2094, 2117, 2118,
2158, 2168, 2236, 2237, 2239, 2240, 2245,
2300, 2307, 2399, 2433, 2491, 2494, 2537,
2578, 2584-2588, 2607, 2691, 2698, 2797,
2826, 2940, 2950, 2962, 3083, 3145, 3167,
3168, 3170-3173, 3291, 3324, 3357, 3423,
3443, 3499, 3501, 3502, 3614, 3615, 3634,
3653, 3716, 3770, 3781, 3784, 3834, 3836-
3839, 3867, 3893, 3906, 3961, 3984, 3992,
4026, 4050, 4111, 4178, 4251, 4262-4267

forest inventory 1154, 1295, 2770, 2786, 3599,
3857, 3946

forest management 26, 50, 89, 112, 156, 189,
250, 257, 262, 372, 373, 431, 453, 475, 480,
547, 557, 606, 675, 680, 693, 703, 719, 724,
748, 749, 768, 819, 839, 842, 850, 880, 882,
884-886, 893, 897, 920, 975, 1045, 1105, 1106,
1257, 1271, 1295, 1388, 1441, 1442, 1488,
1503, 1551, 1568, 1576, 1665, 1676, 1712,
1778, 1800, 1803, 1804, 1806, 1841, 1896,
1913, 2128, 2159, 2209, 2215, 2490, 2549,
2582, 2629, 2650, 2657, 2683, 2720, 2786,
2798, 2830, 2860, 2863, 2891, 2926, 2929,
2940, 3144, 3178, 3179, 3195, 3271, 3297,
3302, 3325, 3345, 3381, 3399, 3411, 3412,
3441, 3529, 3555, 3576, 3608, 3650, 3675,
3685, 3687, 3826, 3857, 3889, 3898, 3964,
3997, 4016, 4080, 4143-4146, 4157, 4242,
4244, 4250

- forest policy 224, 251, 547, 758, 778, 824, 1068,
1322, 1474, 1665, 1714, 1715, 1804, 2330,
2331, 2445, 2446, 2476, 2707, 2708, 2786,
2918, 2923, 3178, 3195, 3264, 3411, 3440,
3574, 3576, 3964, 4056, 4074, 4080
- forest protection 250, 257, 277, 472, 547, 602,
627, 628, 740, 897, 1959, 2182, 2506, 2776,
2910, 3231, 3232, 3328, 3399, 3512, 3543,
3555, 3576, 3622, 3807, 3986, 4164
- forest residues 1274, 1276
- forest tent caterpillar 194, 524, 691, 914, 1257,
1450, 1518, 1554, 1580, 1756, 1813, 1815,
1816, 2374, 2884, 3083, 3087, 3357, 3360,
3361, 3440, 4044, 4187
- forest types 30, 358, 477, 576, 1498, 1573-1575,
1830, 1879, 2476, 2657, 2658, 2677, 2763,
2924, 2954, 3166, 3192, 3205, 3296, 3302,
3323, 3586, 3670
- forest utilization 219, 220, 222, 244, 262, 380,
382, 450, 472, 489, 503, 626, 794, 840, 842,
843, 895, 916, 970, 1071, 1154, 1258, 1291,
1292, 1312, 1313, 1371, 1397, 1445, 1449,
1491, 1562, 1631, 1632, 1635, 1636, 1781,
1795, 1894, 1902, 1976, 2152, 2517, 2549,
2754, 2915, 2940, 2999, 3001, 3022, 3303,
3382, 3426-3432, 3886, 3929, 3953, 3962,
4024, 4288
- France 575, 699, 1399, 2956
- frass 300, 301, 1705, 2034, 2632, 2636, 2653,
2823, 3833
- frost rings 177, 2397
- frosts 367, 941, 1122, 1281, 2946, 3610
- fuelwood 1257, 1371
- functional responses 2126, 2324, 2326, 2566,
2639, 2656, 4312
- fungi 69, 71, 156, 243, 245-247, 249, 612-617,
638, 737, 837, 880, 899, 964, 1041, 1081, 1134,
1135, 1137, 1178, 1298, 1333, 1494, 1609,
1794, 1821, 1828, 1891, 2089, 2125, 2223-
2225, 2265, 2270, 2536, 2538, 2601, 2713,
2714, 2745, 2798, 2889, 3064, 3324, 3443,
3532, 3619, 3620, 3668, 3670, 3671, 3780,
3972, 3973, 4027, 4064, 4196
- fusiform rust 921, 1554
- gall midges 3831
- galls 3048
- gas chromatography 2201, 2912, 4061
- gas-liquid chromatography 801
- generation survival 53, 2184, 2188, 2197, 2383,
2388, 2454, 2459, 2641, 2645, 2651, 2657,
2677, 2679, 4051
- genes 647, 1616, 3510, 3581, 3585
- genetic barriers 3505-3507
- genetics 12, 156, 647-649, 737, 1203, 1205, 1286,
1345, 1527, 1601, 1605, 1608, 1612, 1615,
1616, 1650, 1707, 1737, 2122, 2278, 2329,
2353, 2357, 2714, 2846, 3043, 3064, 3082,
3103, 3111, 3129, 3139, 3140, 3505-3508,
3510, 3564, 3580-3582, 3584, 3585, 3632,
3634, 3636, 3638-3640, 4004, 4174
- geology 1697, 3965
- Germany 575, 611, 699, 1399, 2956, 3306
- grand fir 13, 313, 363, 370, 493, 494, 501, 562,
655-657, 666, 760, 765, 893, 934, 1028, 1031,
1284, 1298, 1475, 1498, 1707, 1861, 1903,
2116, 2152, 2209, 2287, 2288, 2292, 2293,
2296, 2393, 2722, 3010, 3014, 3015, 3122,
3323, 3344, 3357, 3539, 3551, 3645, 3787,
3835, 3840, 3841, 3843, 3848, 3859
- granulosis viruses 385, 386, 388, 390, 907, 910,
2515, 2601, 2624, 3306, 3560, 3592
- grazing 2399

- greater wax moth 3556, 3557
- green larch looper 1813, 1815
- Greenland 2315
- ground spraying 81, 171, 321, 568, 910, 914, 979, 987, 988, 992, 1045, 1347, 1440, 1995, 2492, 3496, 3500, 3592, 3626, 4207
- ground surveys 50, 631, 750, 1357, 1386, 2253, 2254, 2256-2258, 2340, 2341, 2343, 2661, 3025, 3026, 3145, 3728, 3731, 3838, 3908, 4086, 4094
- gut pH 1651
- gypsy moth 113, 336, 365, 558, 658, 741, 921, 934-936, 1121, 1416, 1446, 1518, 1554, 1581, 1644, 1817, 1896, 1979, 2012, 2035, 2081, 2399, 2410, 2557, 2623, 3083, 3265, 3330, 3886, 3887, 4045
- Hammond's flycatcher 2279
- hardwoods 551, 2676, 2677, 3853
- harvesting 244, 250, 257, 262, 382, 473, 489, 644, 842, 843, 879, 1049, 1068, 1276, 1277, 1313, 1337, 1455, 1502, 1619, 1721, 1731, 2056, 2152, 2248, 2249, 2252, 2337, 2345, 2409, 2654, 2684, 2726, 2860, 2863, 2890, 2999, 3178, 3260, 3327, 3328, 3663, 3786, 3792, 3793, 3857, 3898, 3960, 3996, 4142, 4144, 4181, 4282
- harvestmen 1790, 1853, 3990
- hatching 1164, 1296, 1610, 2368, 2413, 2457, 2716, 2803, 2810, 3068, 3072, 3097, 3333, 3497, 3510, 3521, 3590, 3738
- hazard rating 99, 173, 189, 191, 196, 209, 265, 281, 291, 453, 472, 498, 704, 898, 969, 1075, 1116, 1334, 1337, 1505, 1537, 1578, 1660, 1665, 1676, 1698, 1921, 1934, 1935, 1948, 1979, 2006, 2134-2136, 2145, 2146, 2172, 2173, 2176, 2193, 2215, 2216, 2220, 2293, 2335, 2405, 2407, 2408, 2509, 2628, 2671-2673, 2753, 2770, 2997, 2999, 3400, 3406, 3537, 3538, 3608, 3642, 3644, 3645, 3649, 3807-3815, 3886, 3936, 3937, 3958, 3959, 3969, 4086, 4094, 4141, 4142, 4238-4240, 4242, 4243, 4246, 4250, 4281
- head morphology 3553, 3554
- head-capsule measurements 292, 896, 2067, 2376, 3282, 3283, 3366, 3590
- heart rots 2719, 3673
- height increment 494, 697, 765, 3292, 3971, 4184
- Hemiptera 539
- hemlock 1039
- hemlock looper 336, 673, 690, 1257, 1417, 1508, 1824, 2689, 2745, 2852, 2994, 3357, 3360, 3361, 3965, 4178
- hemlock sawfly 1572
- hemocytes 1135-1137
- hemolymph 1262, 1269, 1651, 2034, 2044, 2828, 2829, 3284, 3449, 3460, 3492, 3521, 3581
- herbicides 1622, 1721, 2345, 2776, 3777
- heteropycnosis 3509
- hibernacula 42, 276, 368, 394, 466, 1086, 1320, 1535, 1547, 1602, 1616, 1656, 1726, 1828, 2080, 2352, 2368, 2457, 2464, 3367, 3736, 4131
- hibernation 51, 288, 400, 1440, 1535, 1859, 2057, 3727, 3792
- histology 22, 386, 2529, 2806, 2807, 2887, 3081
- historical aspects 96, 170, 189, 198, 203, 262, 347, 397, 400, 401, 411, 413, 416, 422, 426, 427, 434, 435, 441-444, 447, 449, 450, 452, 456, 522, 534-537, 546, 560, 572, 602, 670, 672, 687, 753, 754, 827, 837, 855, 865, 880, 885, 898, 908, 909, 911, 937, 941, 953, 959, 973, 974, 976, 994, 1006, 1054, 1060, 1063, 1064, 1073, 1074, 1077, 1091, 1096, 1121, 1123, 1134, 1138, 1179, 1189, 1190, 1192, 1198, 1214, 1249, 1254-1256, 1278, 1283, 1284, 1301, 1302, 1308, 1323, 1330, 1342,

- 1343, 1353-1355, 1385, 1423, 1425, 1437, 1451, 1454, 1483, 1485, 1486, 1501, 1504, 1509, 1520, 1536-1539, 1573-1576, 1579, 1586, 1628, 1657, 1658, 1673, 1688, 1702, 1703, 1745, 1754, 1771, 1827, 1858, 1859, 1874, 1904, 1922, 1923, 1939, 1977, 2038, 2066, 2068, 2074, 2077, 2115, 2116, 2120, 2154, 2157, 2177, 2178, 2181, 2185, 2186, 2198, 2246, 2266, 2299, 2303, 2304, 2319, 2368, 2373, 2385, 2449, 2452, 2455, 2476, 2483, 2486, 2511, 2520, 2635, 2637, 2641, 2652, 2656, 2658, 2677, 2691, 2707, 2714, 2716, 2720, 2735, 2753, 2754, 2764, 2777, 2798, 2814, 2817, 2860, 2867-2869, 2873, 2874, 2917, 2918, 2930, 2936, 2938, 2947, 2948, 2950, 2953, 2954, 2985, 2995, 3027, 3030, 3033, 3047, 3101, 3102, 3175, 3185, 3204, 3271, 3298, 3365, 3389, 3391, 3392, 3434, 3439, 3549, 3594, 3617, 3621, 3622, 3659, 3662, 3664, 3665, 3668, 3670, 3673, 3677, 3776, 3797, 3804, 3998, 4003, 4045, 4072, 4073, 4077, 4080, 4082, 4083, 4092, 4093, 4095, 4098, 4099, 4109, 4112-4117, 4134, 4152, 4153, 4176, 4184, 4225, 4263, 4303
- Homoptera** 613, 617
- honey bees** 578, 584, 585, 587-590, 593, 4260
- hormones** 12, 2037, 2465, 4064
- host tree preferences** 20, 1828, 2890, 3505, 3510, 3586, 4217, 4219
- host trees** 182, 195, 293, 295, 397, 398, 416, 426, 435, 442, 510, 536-538, 543, 561, 569, 680, 880, 890, 896, 953, 990, 1096, 1220, 1255, 1257, 1279, 1368, 1401, 1444, 1503, 1506, 1509, 1531, 1584, 1585, 1608, 1649, 1674, 1719, 1756, 1777, 1816, 1859, 1873, 1874, 1911, 2021, 2031, 2055, 2094, 2100, 2102, 2121, 2159, 2352, 2449, 2494, 2497, 2499, 2548, 2554, 2629, 2764, 2777, 2860, 2861, 2898, 3043, 3103, 3177, 3185, 3302, 3501, 3502, 3602, 3614, 3615, 3656, 3657, 3670, 3674, 3684, 3752, 3792, 3839, 4007, 4033, 4074, 4091, 4154, 4184, 4217, 4219
- host/insect asynchrony** 125, 313, 1174-1177, 1903, 3359, 3753
- human health** 174, 181, 508, 509, 589, 678, 748, 749, 876, 997, 1146, 1153, 1173, 1212, 1213, 1370, 1622, 1809, 2250, 2331, 2710, 2755, 2818, 3095, 3191, 3262, 3545, 3546, 3549, 3775, 3777, 4095, 4307
- hybridization** 1488, 1612, 2278, 3213, 3507, 3508, 3510
- hybrids** 648, 1605, 2087, 3505, 3506, 3510
- hydrolysis** 2525, 3108, 3109
- hydropene** 3072
- Hymenoptera** 317, 439, 554, 555, 584, 585, 587-590, 613-617, 706, 1007, 1074, 1118, 1125, 1655, 1859, 2012, 2016, 2063, 2070, 2072, 2093, 2314, 2315, 2378, 2443, 2486, 2487, 2688, 3405, 4017-4019, 4189, 4223
- hyperparasites** 53, 62, 699, 711, 1074, 1399, 2385, 4317
- Ichneumonidae** 2315, 2805
- Idaho** 78, 111, 179, 180, 237, 344, 350, 369-371, 491, 493-497, 632, 633, 653, 654, 656-658, 663, 664, 666, 742, 764-766, 770, 803-815, 844, 966, 1002-1004, 1008, 1023-1026, 1028-1031, 1085, 1088, 1109-1111, 1223-1239, 1244, 1246, 1248, 1249, 1251-1256, 1275, 1288, 1294, 1298, 1328, 1387, 1400, 1412, 1413, 1467, 1468, 1471, 1473, 1561, 1571, 1722, 1723, 1822, 1823, 1861, 1873, 1892, 1904, 1906, 1913, 1914, 1921, 1960, 1962-1965, 1968, 1969, 1984-1986, 1989, 1990, 2106, 2108, 2112-2115, 2117-2119, 2269, 2273, 2281-2284, 2286-2288, 2291, 2293, 2294, 2299, 2341-2343, 2354, 2357, 2367-2370, 2687, 2702, 2780-2782, 2836-2838, 2843, 2847, 2916, 3010, 3014-3016, 3094, 3111, 3140, 3145, 3200, 3203, 3312, 3342, 3344, 3346, 3524, 3525, 3534, 3551, 3625, 3629, 3632, 3638, 3642, 3644, 3690, 3703, 3704, 3706-3709, 3714, 3716, 3720,

- 3721, 3724, 3725, 3729, 3731-3733, 3773,
3787, 3788, 3790, 3834-3841, 3843-3845, 3850,
3851, 3867, 3870-3874, 3891, 3893, 3894,
3897, 3898, 3908, 3921, 3922, 3930, 3947-
3952, 3954-3956, 4015, 4028-4033, 4056, 4147,
4174, 4177, 4178, 4296
- identification keys 538, 717, 718, 926, 1218,
1219, 1570, 1705, 1719, 2090-2092, 2376,
2450, 2653, 2932, 3176, 3181, 3199, 3332,
3591, 3603, 3605, 3779, 4018, 4223
- Illinois 3866, 4279
- illumination 1669, 1670, 3224, 3226, 3251, 4217,
4221
- imported pine budworm 2064
- inclusion bodies 140, 385, 392, 2603, 3564, 4121
- increment reduction 2-4, 31, 33, 34, 138, 167,
190, 260, 261, 265, 344, 369-371, 411, 422,
426, 432, 441, 442, 447, 493, 496, 497, 501,
514, 516, 523, 817, 839, 853, 880, 923, 1015,
1085, 1188, 1283, 1286, 1288, 1297, 1298,
1361, 1386, 1387, 1401, 1541, 1617, 1742,
1756, 1825, 1828, 1970, 2032, 2033, 2050,
2113, 2118, 2214, 2397, 2406, 2449, 2635,
2649, 2671, 2682, 2798, 2890, 2905, 2907,
2908, 2910, 2955, 2966, 2999, 3159, 3273,
3294, 3298, 3526-3529, 3587, 3588, 3595,
3608, 3646, 3673, 3676-3679, 3759, 3908,
3922, 3961, 4010, 4024, 4134, 4175, 4176,
4184, 4313
- Indiana 3866
- information systems 771, 840-842, 1553, 2903,
3155, 4296
- insect growth regulators 420, 564, 566, 588, 592,
619, 636, 737, 899, 1257, 1411, 1479, 1513-
1517, 1801, 1940, 1972, 2149, 2231, 2416,
2489, 2798, 2803-2805, 2809, 2810, 2812,
2993, 3065, 3066, 3070, 3073-3075, 3077,
3083, 3089, 3091, 3092, 3117, 3123, 3125,
3126, 3133, 3136, 3247, 3295, 3318, 3572,
3650, 4064
- insect mortality 53, 171, 216, 234, 277, 438, 464,
482, 500, 568, 575, 578, 589, 599, 643, 658,
713, 808, 809, 828, 966, 1017, 1019, 1123,
1349, 1351, 1420, 1437, 1486, 1536, 1694,
1753, 1827, 1890, 1910, 1944, 1953, 1984,
2033, 2150, 2190, 2283, 2363, 2383, 2384,
2388, 2414, 2448, 2460, 2480, 2491, 2538,
2605, 2633, 2640, 2651, 2658, 2713, 2714,
2856, 2937, 2946, 3125, 3186, 3306, 3314,
3367, 3393, 3410, 3461, 3466, 3599, 3662,
3706, 3738, 3780, 3813, 3863, 4023, 4124,
4156, 4180, 4195, 4209, 4212, 4295
- insect physiology 67, 1139, 1140, 1143, 1144,
1651, 2528, 2828, 3072, 3487
- insecticide degradation 578, 589, 3014, 3015,
3109, 4306
- insecticide registration 678, 1515, 1663, 1972
- insecticide resistance 1007, 1520, 2984, 2985,
3129, 3140, 3636, 3640
- insemination 2802, 3067, 3082
- instars 288, 292, 300, 301, 418, 896, 1169, 1509,
1517, 1535, 1547, 1548, 1559, 1585, 1604,
1605, 1616, 1654, 1656, 1669, 1675, 1726,
1736, 1739, 1770, 1827, 1835, 1837, 1859,
1891, 2028, 2037, 2044, 2067, 2069, 2147,
2150, 2151, 2184, 2197, 2205, 2269, 2324,
2368, 2376, 2378, 2383, 2448, 2452, 2454,
2457, 2464, 2466, 2475, 2482, 2483, 2487,
2489, 2495, 2508, 2566, 2593, 2634, 2660,
2705, 2714, 2728, 2729, 2737, 2739, 2742-
2744, 2805, 2812, 2943, 2984, 2992, 3044,
3047, 3071, 3073, 3078, 3080, 3081, 3085,
3088, 3097, 3103, 3109, 3120, 3121, 3132,
3175, 3185, 3282, 3283, 3313, 3333, 3365,
3366, 3446, 3465, 3477, 3497, 3504, 3506,
3522, 3561, 3569, 3579, 3585, 3586, 3609,
3736, 3738, 3743, 3762, 3764, 3767, 3913,
3972, 3993, 4011, 4037, 4126, 4128, 4129,
4131, 4133, 4152, 4182, 4192, 4196, 4207, 4210
- integrated control 156, 228, 611, 768, 1120, 1361,
1401, 1594, 1745, 1802, 1882, 2021, 2360,
2548, 2554, 2599, 2624, 2684, 3064, 3195,
3265, 3377, 3459, 3478, 4064, 4080, 4160

- integrated pest management 547, 850, 897, 1841,
1913, 1978, 2445, 2446, 2490, 2551, 2891,
3399, 3411, 3555, 3570, 4160, 4179
- internal electrical resistance 3376
- international units 2599, 2607, 2609, 2610, 2621
- introduced pine sawfly 2374
- iodofenphos 153
- Iowa 3866, 4279
- isolation mechanisms 647, 3213, 3505-3507, 3510
- isothioureas 3128
- isozymes 1606, 1608, 3111, 3639
- jack pine 268, 283, 329, 330, 332, 339, 773, 1089,
1194, 1348, 1384, 1506, 1508, 1657, 1744,
1755, 1821, 2032, 2418, 2498, 2499, 2759,
2858, 2931, 3122, 3192, 3255, 3331, 3613,
3619, 3875, 4161, 4251
- jack pine budworm 42, 47, 51-53, 61, 102, 133-
136, 182, 218, 264, 268, 270, 271, 279, 282-
284, 322, 324-339, 348, 356, 375, 376, 510,
511, 519, 520, 529, 530, 533, 540, 543, 646,
667, 669, 672, 674, 682, 683, 686, 689, 697,
721, 772, 773, 823, 877, 889, 971, 990-992,
994, 1073-1077, 1089, 1125, 1194, 1202, 1221,
1222, 1348-1351, 1384, 1385, 1404, 1426,
1437, 1500, 1502, 1506, 1511, 1558, 1671,
1674, 1686, 1695, 1696, 1701-1703, 1755,
1773, 1774, 1788, 1797, 1813, 1815, 1819,
1821, 1825, 1831, 1835, 1837-1839, 1842-1846,
1856, 1875, 1980, 2026-2033, 2067-2069, 2094,
2153, 2158, 2159, 2206, 2207, 2227-2229,
2235, 2270, 2300, 2324-2326, 2338, 2358,
2418, 2442, 2494-2496, 2498-2503, 2507, 2508,
2560, 2562, 2563, 2670-2673, 2733, 2743,
2759, 2797, 2826, 2827, 2850, 2851, 2879,
2884, 2900, 2931, 2938, 2955, 3028, 3043,
3050-3061, 3101, 3103, 3113, 3122, 3141,
3142, 3167, 3169, 3170, 3172, 3178, 3179,
3181, 3192, 3207, 3331, 3383, 3385, 3418,
3435, 3442, 3505, 3507, 3508, 3533, 3558,
3581, 3596, 3597, 3613-3615, 3686, 3688,
3761, 3770-3772, 3785, 3866, 3875, 3876,
3906, 4091, 4112-4116, 4216, 4222, 4228-4234,
4251, 4279
- jack pine sawfly 268, 914, 1502
- jack pine tip beetle 4222
- Japan 643, 1885, 1887, 3045, 3655
- Japanese larch 1744
- juniper scale 2374
- juvenile hormones 420, 588, 592, 593, 837, 1514,
1517, 1699, 2389, 2803, 2805, 2809, 2810,
2812, 2823, 2824, 3064, 3068, 3071-3073,
3083, 3085, 3088, 3097, 3115, 3127, 3137,
3313, 3318, 3504, 4064
- kairomones 1742, 1743, 1798, 3833
- Kansas 1480, 1654
- Kentucky 1403
- key factors 2486, 2640, 2647
- L 1215 3066
- L 7063 3066
- Labrador 785, 786, 788-791, 1212, 1213, 2558,
2559, 2565, 2592, 2721
- lacky moth 914
- lady beetle 3979
- larch bud moth 914
- larch casebearer 524, 1288, 2093, 2374, 3094,
4178
- larch sawfly 336, 524, 1345, 1504, 1510, 1812,
1813, 1815, 2056, 2374, 2682, 2691, 2885,
2939, 3048, 3357
- large aspen tortrix 903, 1756, 1813, 1815, 3122
- larvae 198, 227, 367, 368, 717, 718, 1119, 1143,
1164, 1447, 1448, 1514, 1613, 1654, 1909,

- 1951, 1967, 2008, 2028, 2029, 2033, 2034, 2057, 2071, 2149, 2155, 2184, 2205, 2207, 2224, 2324, 2328, 2352, 2368, 2375, 2376, 2383, 2398, 2413, 2447, 2451, 2452, 2464-2466, 2472, 2495, 2567, 2599, 2645, 2652, 2714, 2728, 2729, 2737, 2739, 2743, 2744, 2746, 2812, 2828, 2863, 2867, 2890, 2930, 2937, 2943, 2984, 2985, 3028, 3045, 3071, 3073, 3078, 3080, 3081, 3085, 3088, 3097, 3103, 3106, 3107, 3109, 3120, 3121, 3129, 3185, 3281, 3283, 3294, 3300, 3321, 3333, 3335, 3338, 3339, 3365, 3367, 3372, 3408, 3446, 3453, 3465, 3469, 3477, 3485, 3487, 3492, 3497, 3504, 3521, 3522, 3561, 3565, 3569, 3585, 3586, 3609, 3655, 3663, 3673, 3736, 3738, 3743, 3762, 3830, 3972, 3993, 4000, 4004, 4017, 4021, 4025, 4037, 4119, 4122, 4125, 4126, 4128, 4129, 4131, 4133, 4136, 4152, 4192, 4207, 4215, 4290
- larval age 300, 2812, 3313, 4196
- larval behavior 161, 279, 1164, 1615, 1669, 1905, 2080, 4128, 4129, 4131, 4136
- larval body temperature 3372, 4125, 4136
- larval color 3284, 4007
- larval density 303, 709, 772, 858, 1073, 1300, 1314, 1351, 1704, 1724, 1854, 1984, 2027, 2068, 2194, 2253, 2254, 2305, 2344, 2458, 2486, 2487, 2505, 2566, 2599, 2618, 2639, 2641, 2643, 2653, 2675, 2840, 2862, 2966, 2977, 3026, 3159, 3182, 3276, 3300, 3513, 3588, 3589, 3631, 3658, 3727, 3768, 3972, 4038, 4049
- larval development 289, 306, 368, 384, 409, 438, 439, 463, 466, 517, 518, 543, 635, 649, 650, 733, 734, 740, 812, 861, 1053, 1062, 1136, 1142, 1143, 1147, 1167-1169, 1174-1177, 1440, 1469, 1530, 1535, 1538, 1599, 1602-1605, 1610, 1616, 1656, 1671, 1777, 1828, 1940, 2000, 2037, 2067, 2069, 2088, 2147, 2187, 2317, 2368, 2376, 2411, 2413, 2469, 2557, 2593, 2714, 2984, 2997, 3034, 3041, 3080, 3085, 3121, 3175, 3313, 3358, 3366, 3378, 3477, 3510, 3579, 3633, 3656, 3756, 3765, 3767, 3856, 4006, 4011, 4081, 4126, 4156
- larval dispersal 267, 272, 275, 279, 282, 315, 410, 412, 448, 499, 671, 776, 777, 1101, 1164, 1271, 1349, 1351, 1490, 1531, 1539, 1669, 1743, 1829, 1834, 1843, 1849, 1854, 1908, 1909, 2067, 2069, 2080, 2410, 2414, 2448, 2449, 2464, 2475, 2643, 2658, 2660, 2677, 2943, 2954, 2972, 3036, 3044, 3175, 3180, 3307, 3338, 3398, 3412, 3638, 3658, 3727, 3735, 3738, 3752, 4131, 4133, 4135, 4174, 4301
- larval droppage 279, 1164, 1451, 1669, 1835, 1837, 1847, 2178, 2639, 2937, 3363, 3610, 3658, 4084
- larval emergence 288, 439, 466, 1602, 1726, 1905, 2074, 2080, 2104, 2192, 2368, 2413, 2457, 2469, 2643, 3044, 3175, 3281, 3338, 3367, 3497, 3510, 3727, 3736, 3758, 3792, 4005, 4006, 4009
- larval infection 4207, 4210
- larval mandibles 2324, 2567
- larval morphology 873, 1613, 1654, 2067, 2090, 2205, 2376, 2450, 2567, 3107
- larval mortality 70, 217, 387, 394, 408, 425, 438, 486, 517, 518, 553, 737, 968, 1101, 1349, 1384, 1609, 1827-1829, 1834, 2022, 2043, 2046, 2080, 2104, 2126, 2127, 2178, 2269, 2272, 2403, 2451, 2454, 2464, 2467, 2475, 2485, 2505, 2526, 2532, 2566, 2593, 2599, 2605, 2613, 2625, 2643, 2660, 2705, 2714, 2742, 2937, 2980, 2995, 3026, 3047, 3085, 3276, 3306, 3315, 3333, 3356, 3363, 3365, 3367, 3412, 3445, 3446, 3449, 3453, 3463, 3465, 3469, 3471, 3477, 3486, 3487, 3560, 3567, 3579, 3593, 3609, 3658, 3727, 3738, 3767, 3778, 3827, 4037, 4078, 4083, 4084, 4152, 4153, 4192, 4193, 4202
- larval parasites 486, 575, 712, 744, 925, 1589, 1826, 1915, 2040, 2378, 2454, 2487, 2609, 2706, 2946, 3277, 3367, 3398, 3405, 3408, 3764, 3787, 3833, 3993, 4017, 4173, 4183, 4196, 4235, 4317

- larval sampling 50, 171, 192, 198, 290, 302, 307, 343, 344, 454, 657, 706, 708, 713, 714, 750, 752, 762, 807, 815, 825, 858, 859, 863, 864, 896, 904, 978, 989, 1057, 1079, 1080, 1082, 1116, 1132, 1272, 1300, 1348, 1350, 1413, 1590, 1591, 1760, 1780, 1849, 1854, 1915, 1917, 2027, 2106, 2114, 2251, 2258-2261, 2263, 2264, 2303, 2305, 2311, 2365, 2366, 2377, 2380, 2442, 2448, 2456, 2471, 2478, 2479, 2481, 2483, 2495, 2496, 2509, 2549, 2565, 2574, 2576, 2577, 2580, 2593, 2608, 2632, 2642, 2648, 2652, 2674, 2723, 2804, 2842, 2862, 2865, 2924, 2937, 2966, 2983, 3024, 3211, 3246, 3276, 3300, 3367, 3394, 3401, 3403, 3513, 3514, 3537, 3538, 3551, 3567, 3721, 3722, 3727, 3835, 3871, 3933, 3972, 3973, 4021, 4022, 4038, 4089, 4210, 4215, 4280
- larval survival 267, 412, 438, 448, 1101, 1167, 1168, 1177, 1349, 1602, 1615, 1828, 1905, 2069, 2178, 2188, 2191, 2192, 2197, 2411, 2412, 2454, 2475, 2505, 2605, 2634, 2645, 2675, 2677, 2705, 3041, 3097, 3185, 3336, 3338, 3339, 3408, 3567, 3610, 3743, 4049, 4131
- larval weight 1169, 1177, 3121, 3504, 4192
- laser holography 3107
- lead arsenate 75, 190, 336, 338, 400, 487, 522, 526, 763, 779, 1240-1243, 1385, 1440, 1502, 1859, 2153, 2352, 2492, 2783, 3496, 3540, 4286
- lecanium scale 2374
- Leconte's sawfly 130
- Lepidoptera 62, 533, 539, 588, 613-617, 713, 717, 718, 928, 932, 934, 1652, 1775, 1891, 2012, 2016, 2090, 2092, 2315, 2417, 2762, 2811, 2884, 2932, 3167, 3523, 3800, 4189
- leptophos 328, 1728
- life history 81, 84, 96, 100, 120, 123, 182, 190, 191, 284, 287, 293, 295, 317, 346, 374, 397-400, 522, 551, 554, 555, 557, 561, 641, 642, 679, 683-685, 694, 695, 713, 826, 880, 890, 896, 955, 970, 974, 996, 1138, 1241, 1242, 1249, 1254, 1256, 1279, 1286, 1373, 1399, 1414, 1470, 1490, 1503, 1506, 1511, 1649, 1656, 1717-1719, 1745, 1755, 1756, 1775, 1873, 1908, 1943, 1985, 2021, 2055, 2093, 2097, 2101, 2102, 2158, 2159, 2206, 2246, 2268, 2282, 2365, 2368, 2369, 2402, 2434, 2448, 2466, 2468, 2498, 2516, 2548, 2549, 2554, 2561, 2661, 2720, 2753, 2764, 2772, 2773, 2777, 2816, 2817, 2859-2861, 2897, 2898, 2943, 3048, 3163, 3174, 3177, 3180, 3242, 3272, 3329, 3352, 3419, 3434, 3436, 3495, 3513, 3549, 3560, 3571, 3602, 3657, 3666, 3671, 3672, 3687, 3721, 3776, 3797, 3945, 3948, 3951, 3979, 4001, 4141, 4154, 4166, 4167, 4235, 4249
- life stages 122, 284, 295, 400, 554, 555, 557, 683, 684, 826, 1073, 1399, 1440, 1469, 1487, 1514, 1895, 2317, 2368, 2457, 2466, 2817, 2867, 3179, 3352, 3418, 3549, 3673, 3687, 4154
- life tables 282, 654, 1349, 1351, 1742, 2383, 2384, 2451, 2465, 2466, 2648, 2651, 2657, 2658, 2677, 3186-3188
- light reactions 1547, 1669, 1670, 4129, 4133, 4136, 4217
- light traps 50, 198, 858-861, 863, 864, 1016, 1119, 1529, 1533, 1539, 1774, 2251, 2253-2264, 2472, 2473, 2632, 2636, 2864, 2866, 2867, 2870, 3246, 3396, 3404, 3413, 3421, 3422, 3928
- lindane 338, 1385
- literature reviews 156, 182, 242, 264, 383, 456, 599, 626, 638, 761, 792, 889, 914, 1173, 1193, 1259, 1313, 1419, 1652, 1666, 1818, 2026, 2035, 2060, 2270, 2304, 2377, 2468, 2629, 2641, 2642, 2667, 2690, 2698, 2714, 2733, 2794, 2833, 2923, 2999, 3317, 3375, 3424, 3563, 3878, 3880, 3882, 3883, 3903, 3905, 3965, 3999, 4130, 4173, 4299
- litter-dwelling arthropods 1276, 3990
- littleleaf disease 1554

- loblolly pine sawfly 914
- locust borer 194
- lodgepole needleminer 921, 2374, 3357
- lodgepole pine 130, 195, 363, 370, 374, 606,
1028-1030, 1108, 1219, 2682, 2931, 3539, 3571
- lodgepole sawfly 487
- long-term effects 1770, 2593, 2599, 2600, 2608,
2609, 2613, 2702, 2814, 2962, 3021, 3610,
3681, 3978, 3990, 4080
- losses 848, 1472, 1504, 2692, 2754, 2757, 3970,
4045, 4108, 4157
- lumber 219, 222, 244, 1258, 1371, 1491, 3427,
3431, 3432, 3929, 4309
- magnolia warbler 622, 624, 2656
- Maine 1, 10, 41, 45, 46, 60, 76, 77, 83, 89, 104-
106, 120, 162, 165-167, 224, 238, 261, 296,
297, 305, 310, 351-354, 366, 380-382, 397-401,
426, 428, 435, 437, 446, 471, 474, 476, 488,
490, 512-516, 522, 532, 533, 548-552, 556, 566,
568, 618, 619, 729, 730, 794, 816, 821, 822,
839-843, 858-865, 869-872, 878, 883-887, 916-
919, 969, 976, 1015, 1016, 1037, 1038, 1040,
1042-1044, 1046-1054, 1056-1061, 1063, 1064,
1066-1070, 1113, 1116, 1124, 1126, 1127,
1138, 1150-1152, 1154, 1196, 1258, 1259,
1295, 1296, 1313, 1325, 1334, 1336, 1363,
1371-1374, 1389-1392, 1396, 1397, 1440, 1445,
1455-1465, 1486, 1487, 1489, 1512, 1513,
1515, 1523, 1524, 1543, 1562, 1564-1567,
1575, 1594, 1596, 1650, 1659, 1665, 1676,
1720, 1741, 1743, 1744, 1746-1748, 1750-1752,
1782, 1783, 1785-1787, 1790-1792, 1800, 1802,
1804, 1805, 1826, 1827, 1831-1834, 1840,
1842, 1843, 1847, 1849, 1850, 1852-1855,
1858-1860, 1863, 1882-1884, 1896, 1909-1912,
1915-1918, 1959, 1966, 1967, 1970, 1988,
2006, 2007, 2010, 2011, 2022, 2048-2050,
2052, 2070-2073, 2079, 2121, 2133, 2155-2157,
2231, 2248, 2251-2268, 2275, 2280, 2297,
2329, 2333, 2345-2350, 2406-2409, 2444, 2449,
2504, 2506, 2509, 2516-2519, 2523, 2532,
2582, 2590-2592, 2663, 2666, 2684, 2706-2708,
2712, 2717, 2764, 2766-2768, 2785, 2787,
2788, 2793, 2814-2817, 2859-2874, 2894, 2895,
2903, 2918, 2929, 2958-2962, 3004, 3095,
3096, 3146, 3147, 3194, 3195, 3268, 3272,
3273, 3305, 3321, 3322, 3324, 3328, 3350,
3353, 3374, 3376, 3379-3382, 3394-3396, 3398-
3401, 3404, 3405, 3408-3410, 3413, 3420,
3432, 3519, 3527-3530, 3532, 3535, 3537,
3538, 3541-3544, 3567-3569, 3573-3577, 3611,
3612, 3632, 3647-3649, 3675, 3747, 3779,
3801-3825, 3832, 3833, 3877-3882, 3887, 3910,
3911, 3924, 3928, 3959, 3962, 3972-3974,
4022-4024, 4035, 4036, 4039, 4041-4043, 4092,
4109, 4118, 4145, 4185, 4225, 4273, 4274,
4276, 4289
- Malaise traps 3246
- malathion 102, 123, 126, 153, 270, 271, 336-338,
398, 602, 605, 684, 685, 763, 987, 1057, 1058,
1096, 1275, 1560, 1644, 1708, 1717, 1985,
2018, 2077, 2100, 2115, 2150, 2264, 2498,
2500, 2507, 2508, 2847, 2964, 2991, 3038,
3124, 3135, 3140, 3156, 3157, 3191, 3314,
3315, 3496, 3513, 3524, 3694, 3695, 3713,
3730, 3895, 3896, 3900, 3926, 3931, 3951, 4169
- male moths 359, 926, 3084, 3213, 3215, 3222,
3224, 3226, 3247, 3249, 3252, 3539, 4059,
4065, 4129, 4220
- male reproductive system 11, 12, 2807, 2813,
3063, 3080, 3081
- mammalian toxicity 2728, 2737
- mammals 29, 174, 305, 342, 350, 578, 581, 585,
587, 588, 590-594, 596-598, 600, 658, 742, 837,
901, 915, 975, 1007, 1054, 1069, 1115, 1173,
1212, 1213, 1476, 1813, 2057, 2197, 2326,
2333, 2415, 2505, 2524, 2525, 2639, 2655,
2656, 2661, 2718, 2721, 2728, 2733, 2734,
2737, 2740, 2745, 2774, 2775, 2894, 2916,
2952, 2986, 3374, 3408, 3681, 3906, 3963,
3984, 3989, 4015

- management options 26, 28, 475, 632, 633, 922, 924, 1284, 1806, 2099, 2312, 2445, 2446, 2509, 2754, 2759, 2891, 2967-2970, 3158, 3160, 3178, 3411, 3537, 3538, 3575, 3577, 3645, 3696, 3697, 3877-3880, 3882, 3884, 3903, 3905, 3917, 3949, 3950
- Manitoba 85, 203, 216, 217, 510, 511, 531, 543, 579, 582, 588, 596, 721, 986, 989, 991, 992, 994, 995, 1104, 1201, 1202, 1314, 1315, 1326, 1436, 1437, 1575, 1673, 1674, 1683, 1686-1688, 1695, 1696, 1813-1816, 2065, 2066, 2206, 2358, 2418, 2562, 2563, 2591, 2723, 2743, 2849-2851, 2900, 2953, 2954, 3028, 3029, 3101, 3103, 3141, 3142, 3424, 3432, 3572, 3663, 3860, 4017, 4251
- maple dieback 2695
- mapping 25, 199, 450, 512, 513, 544, 576, 820, 840, 842, 843, 864, 1049, 1362, 1537, 1676, 1812, 2230, 2408, 2582, 2628, 2693, 2726, 2903, 3327, 3357, 3400, 3441, 3757, 3959, 4092, 4296
- maps 1579, 1659, 1763, 1771, 1812, 1922, 1923, 2074, 2266, 2476, 2495, 2903, 3204, 3433, 3441, 3969, 4082
- marketing 489, 619, 794, 1198, 2007, 2249, 2252, 2549, 3426, 3427, 3430, 3432
- markets 1779, 4237
- Maryland 1812
- Massachusetts 1403
- mating 51, 359, 383, 647, 648, 650, 896, 929, 1530, 1547, 1610, 1819, 2069, 2087, 2368, 2411, 2489, 2802, 2803, 2808, 2809, 2812, 2813, 3067, 3078, 3082, 3088, 3215, 3216, 3224, 3229, 3250, 3251, 3286, 3287, 3289, 3333, 3505, 3506, 3510, 3539, 3585, 3737, 3767, 4007, 4220
- mating behavior 2085
- mating disruption 36, 37, 383, 933, 1047, 2821, 3214-3217, 3219, 3241, 3247, 3251, 3254, 3384
- mayflies 111, 1520, 2961
- menazon 2980
- metabolism 11, 12, 1140, 1141, 1789, 1810, 2037, 2524, 2525, 2848, 3108, 3459, 3472, 3492, 3585
- metabolites 2403, 3492
- metamorphosis 3097, 3313, 3565
- meteorological factors 1183, 1668-1670, 1689, 1690, 1693, 1913, 2269, 4133
- metepa 3084
- methamidophos 2115, 3010, 3014, 3015
- methomyl 153, 323, 568, 987, 1055, 1560, 1641, 2044, 2115, 2117, 2281, 2288, 2883, 3132, 3135, 3334, 3344, 3503, 3504, 3925, 3926
- methoprene 3071, 3072, 3123, 3136, 3137
- methoxychlor 3926
- mexacarbamates 3108
- mexacarbate 104, 120, 153, 239-241, 270, 271, 293, 336, 337, 483, 487, 488, 581, 595, 598, 605, 763, 861-863, 1012, 1025, 1036, 1067, 1096, 1126, 1138, 1275, 1385, 1471, 1644, 1662, 1663, 1694, 1724, 1745, 1935, 1938, 2046, 2070, 2108, 2115, 2199, 2273, 2346, 2347, 2363, 2366, 2370, 2498, 2525, 2570, 2727, 2729, 2732, 2737, 2740, 2743, 2744, 2819, 2912, 2916, 2959, 2991, 3104, 3106, 3120, 3121, 3129, 3132, 3134, 3269, 3270, 3299, 3504, 3524, 3567-3569, 3647, 3649, 3690, 3711, 3778, 3807, 3811, 3872, 3881, 3891, 3930, 3952, 4177, 4180, 4182, 4183
- mice 1901
- Michigan 1, 42, 45-47, 52, 53, 61, 102, 130, 264, 270, 271, 329-331, 334, 335, 357, 543, 1073,

- 1075, 1125, 1194, 1337, 1348, 1349, 1351, 1365, 1367, 1368, 1378, 1380-1382, 1384, 1385, 1392, 1490, 1502, 1505, 1506, 1508, 1618-1620, 1685, 1698, 1779, 1886, 1888, 1908, 2079, 2134-2144, 2146, 2324, 2326, 2334, 2335, 2338, 2352, 2442, 2496, 2498-2501, 2508, 2533, 2534, 2546, 2548, 2549, 2554, 2670-2673, 2759, 2760, 2975, 2977, 3011, 3151, 3154, 3399, 3407, 3414, 3415, 3418, 3419, 3432, 3861, 3866, 3876, 3942, 4237, 4239, 4240, 4242-4244, 4246, 4249, 4279
- microbial insecticides 27, 40, 72-74, 83, 97, 103, 113, 120, 127, 139, 152, 155, 156, 229, 230, 235, 236, 293, 310, 345, 415, 420, 437, 472, 500, 582, 602, 610, 633, 676, 679, 690, 691, 723, 726, 727, 731, 733-737, 739, 740, 822, 899, 900, 981, 986, 988, 993, 1007, 1036, 1037, 1040, 1041, 1044, 1045, 1050, 1051, 1055, 1060-1062, 1112, 1115, 1128, 1138, 1146, 1151, 1173, 1210, 1212, 1213, 1257, 1261, 1263, 1264, 1267, 1268, 1275, 1279, 1361, 1370, 1485, 1526, 1527, 1543, 1552, 1560, 1594, 1597, 1640, 1700, 1729, 1745, 1762, 1770, 1784, 1794, 1803, 1807, 1882, 1891, 1899, 1924, 1925, 1941, 1947, 1966, 1968, 1992, 2078, 2079, 2081, 2083, 2097, 2100, 2120, 2124, 2129, 2181, 2244, 2252, 2265, 2270, 2295, 2344, 2348, 2349, 2364, 2389, 2422, 2489, 2506, 2516, 2520, 2536, 2543, 2590-2595, 2597, 2602-2604, 2606-2611, 2613-2623, 2625-2627, 2680, 2718, 2721, 2739, 2745, 2753, 2755, 2756, 2766, 2787, 2798, 2800, 2875, 2876, 2907, 2949, 2963-2965, 3005, 3008, 3009, 3011, 3012, 3090, 3156, 3157, 3161, 3163, 3195, 3196, 3295, 3304, 3368, 3419, 3444, 3445, 3447, 3448, 3450-3459, 3461-3465, 3467-3469, 3471-3481, 3483-3491, 3493, 3511, 3516, 3517, 3532, 3560, 3563, 3577, 3578, 3622, 3626, 3630, 3631, 3691, 3694, 3695, 3700, 3701, 3749, 3806, 3807, 3809-3812, 3815, 3856, 3909, 3911, 3912, 3925, 3926, 3948, 3951, 4022, 4159, 4190, 4200, 4207, 4249, 4292, 4294
- microclimate 2067, 2714, 4126
- microsporidia 612-617, 737, 912, 1041, 1081, 1333, 1610, 1666, 1794, 1810, 2489, 2601, 2613, 2713-2715, 2747, 2798, 2885, 2886, 3064, 3443, 3459, 3466, 3469, 3470, 3743, 3760, 3761, 3763-3769, 4064, 4187-4191, 4193-4214, 4294
- Minnesota 61, 84, 219-222, 264, 265, 267, 269, 272-282, 285, 288-292, 299, 303, 306, 357, 503, 543, 719, 1291, 1337, 1364, 1365, 1368, 1385, 1491, 1499, 1502-1505, 1509, 1510, 1620, 1632, 1657, 1658, 1661, 1701-1703, 1825, 1843, 1875, 1888, 2029-2032, 2056, 2057, 2121-2123, 2146, 2153, 2154, 2218, 2327, 2338, 2495, 2497, 2502, 2503, 2505, 2546, 2548, 2549, 2554, 2695, 2748, 2763, 3151, 3154, 3193, 3204, 3298, 3300, 3399, 3425, 3426, 3429, 3431, 3432, 3861, 3866, 3876, 3937, 3941, 4107, 4108, 4139, 4199, 4217-4219, 4223, 4224, 4242, 4279
- Missouri 3866, 4279
- mist blowers 982, 987, 988, 1347, 2618, 2625, 4207, 4208
- mites 558, 804, 805, 1278, 1743, 1746, 2126, 2300, 2491, 2494, 3800, 3868, 3906
- mixed stands 1624, 2676, 2677
- models 261, 498, 606, 802, 824, 893, 898, 927, 1183, 1199, 1323, 1335, 1360, 1401, 1646, 1647, 2136, 2296, 2298, 2461, 2679, 2891, 2924, 3035, 3041, 3178, 3325, 3575, 3577, 3636, 3640, 3642, 3645, 4050, 4053, 4177
- Modoc budworm 680, 706, 922-924, 1096, 1297, 1492, 1844-1846, 2084-2087, 2897, 2914, 3113, 3323, 3632, 3635, 3688, 3785, 4003, 4005
- Montana 3930
- Montana 78, 79, 119, 130, 225, 227, 230, 234-236, 240, 241, 402, 492, 493, 495, 500-502, 605, 653, 655, 657, 659, 663, 665, 666, 702, 704, 705, 744-747, 759, 766, 767, 770, 828, 966, 967, 999-1003, 1005-1008, 1018-1024, 1026-1030, 1085, 1086, 1088, 1108-1111, 1182, 1223-1239, 1244-1246, 1248, 1251-1253, 1270,

- 1273, 1275-1278, 1280, 1281, 1283, 1285,
1287, 1288, 1318, 1327-1329, 1386, 1472,
1496, 1497, 1551, 1559, 1561, 1571, 1621,
1638, 1691-1693, 1709, 1722-1724, 1811, 1820,
1822, 1831, 1842, 1843, 1861, 1864-1873,
1904, 1906, 1913, 1914, 1989-1995, 1997,
1998, 2018, 2046, 2150, 2271, 2279, 2289,
2290, 2295, 2341-2343, 2351, 2353, 2357,
2362-2366, 2368-2370, 2441, 2511, 2702, 2769,
2834, 2912, 2913, 2916, 3007, 3094, 3098,
3099, 3111, 3140, 3145, 3200, 3280, 3292,
3293, 3314-3316, 3344, 3346-3349, 3622, 3624,
3627, 3628, 3630, 3631, 3637, 3638, 3703-
3726, 3729-3733, 3735, 3787, 3788, 3790,
3834-3842, 3844-3851, 3856, 3867, 3870, 3892-
3898, 3908, 3921-3923, 3931, 3935, 3940,
3945, 3947, 3948, 3951, 3952, 4056, 4147,
4174, 4176-4178, 4180-4183, 4297, 4298, 4300,
4301, 4314
- morphology** 8, 16, 22, 23, 96, 543, 1155, 1404,
1406, 1407, 1613, 1654, 2121, 2368, 2402,
2528-2530, 2621, 2806, 2807, 2846, 2887,
3107, 3223, 3224, 3238, 3271, 3552, 4091, 4136
- moth age** 359, 1155, 2802, 2808, 2887, 3226, 3251
- moth behavior** 36, 38, 849, 1374, 1669, 1670,
1689, 1833, 2483, 3084, 3213, 3215, 3226,
3250, 3252, 3254, 3257, 3383, 3384, 3388,
3395, 3539, 4123, 4129, 4217, 4220, 4221
- moth density** 1732, 2483, 2943
- moth diseases** 2715, 4207
- moth dispersal** 275, 456, 457, 523, 527, 671, 776,
777, 934, 935, 1033, 1271, 1324, 1349, 1374,
1487, 1490, 1528-1534, 1536, 1539, 1540,
1668-1670, 1689, 1908, 1912, 2189, 2256,
2258, 2261, 2317, 2410, 2414, 2447, 2449,
2452, 2472, 2474, 2480, 2483, 2593, 2634,
2658, 2661, 2677, 2820, 2866, 2917, 2943,
2954, 2972-2974, 3028, 3035, 3180, 3188,
3190, 3218, 3227, 3231, 3232, 3236, 3256,
3307, 3359, 3406, 3421, 3422, 3569, 3610,
3638, 3724, 3752, 3800, 3809, 3945, 4010,
4133, 4174, 4277
- moth emergence** 953, 1440, 2368, 2607, 2609,
2613, 2705, 2802, 2803, 2809, 2887, 3078,
3224, 3250, 3251, 3510, 4078
- moth invasions** 48, 527, 1032, 1083, 1530, 1533,
1534, 1539, 1859, 2317, 2472, 2483, 2593,
2867, 3002, 3569, 4036, 4041, 4080
- moth longevity** 940, 2803, 3035, 3765, 3767, 4202
- moth morphology** 21, 24, 873, 926, 1404-1407,
2527, 2530, 2531
- moth sampling** 43, 44, 46, 48, 454, 750, 752, 859,
860, 863, 864, 930, 1016, 1606, 1750, 1780,
1819, 1857, 1940, 2149, 2168, 2253-2261,
2263, 2264, 2472, 2480, 2483, 2549, 2632,
2648, 2866, 2924, 2975, 2977, 3211, 3222,
3233, 3235, 3246, 3266, 3267, 3373, 3396,
3413, 3422, 3724, 3729, 4109
- moth size** 1053, 1603, 1828, 2452, 3250
- moth spraying** 1528, 1532, 2774
- moth survival** 1349, 1536, 2189
- moth weight** 1603, 2322, 3339
- moths** 663, 930, 1155, 1509, 1528, 1530, 1534,
1535, 1547, 1668, 1689, 1833, 1859, 1940,
1945, 2033, 2044, 2184, 2196, 2205, 2317,
2352, 2368, 2383, 2447, 2457, 2466, 2474,
2488, 2489, 2593, 2607, 2609, 2613, 2632,
2636, 2677, 2705, 2714, 2715, 2806, 2807,
2823, 2864, 2866, 2917, 2943, 3028, 3078,
3082, 3084, 3088, 3126, 3190, 3215, 3222,
3224, 3238, 3247, 3249-3251, 3256, 3334,
3395, 3406, 3422, 3506, 3510, 3552-3554,
3565, 3580-3582, 3585, 3742, 3746, 3764,
3767, 4004, 4008, 4057, 4059, 4065, 4109,
4129, 4133, 4207, 4217, 4219-4221
- mottled umber moth** 914
- moult inhibitors** 565, 567, 1479, 1514, 1516-
1518, 2993, 3064, 3069, 3070, 3073-3075,
3077, 3119
- moulting** 1616, 2037, 2984, 3097

- mountain hemlock 3139, 3840
- mountain maple 894, 3996
- mountain pine beetle 129, 130, 363, 364, 524,
606, 607, 767, 768, 805, 921, 1209, 1644, 1979,
2399, 2441, 2560, 2893, 3534, 3921
- mountain pine cone beetle 1030
- mountain-ash sawfly 2374, 3048
- multiple matings 2802, 2808, 3067, 3224
- musculature 21, 2527, 2531, 2888
- mutations 12, 3585
- myrtle warbler 2656
- naled 153, 326, 336, 337, 1275, 1560, 2916, 3926,
4182, 4183
- Nantucket pine tip moth 1508, 4044
- natural enemies 1891, 2479, 2600, 2658, 3982
- natural mortality 1423, 2384, 2610, 2636, 2651,
2652, 2657, 2941, 2943, 3410, 3658, 3982,
4080, 4099, 4153
- navel orangeworm 2428
- Nebraska 1480, 1821, 3331, 4279
- needle density 751, 4217, 4224
- needle length 2581, 4279
- needle mining 169, 367, 466, 518, 896, 1039,
1828, 1829, 2027, 2029, 2376, 2643, 2705,
2867, 3590, 3610
- needle temperature 4126
- needle weight 751
- needles 751, 1266, 1675, 1829, 2029, 2269, 2376,
2493, 2581, 3340, 3553, 4126, 4217, 4224, 4279
- nematodes 613, 614, 837, 899, 1320, 1321, 1891-
1893, 2089, 2270, 2601, 3301, 3901, 3906
- nervous system 2527, 3311, 3313, 3503, 3778
- nestlings 1448, 3197, 3418
- Nevada 180, 1962, 1963, 1968, 1969, 2367, 2780,
2781, 2836-2838, 2843, 3200, 3202, 3203,
3534, 3873, 3874, 4030
- New Brunswick 36-38, 74, 88, 90, 98, 99, 109,
110, 114, 120, 121, 125, 177, 181, 183-189,
191, 193, 196-199, 201, 204-213, 250-256, 258-
261, 304, 307, 340-342, 428, 435, 437, 446,
504, 509, 531, 554, 588, 589, 594, 595, 624,
625, 627-629, 641-643, 671, 673, 723, 724, 738,
739, 758, 778, 798, 801, 845, 846, 874-876,
878, 880-882, 894, 897, 898, 963, 964, 979,
984, 989, 1009, 1032-1035, 1072, 1083, 1084,
1105, 1113, 1133, 1134, 1153, 1159-1162,
1165, 1166, 1168, 1169, 1171, 1172, 1174-
1176, 1179, 1180, 1186, 1187, 1191, 1195,
1198, 1199, 1211, 1216, 1289, 1301, 1304,
1322-1324, 1339-1344, 1352-1359, 1377, 1429-
1431, 1437, 1476, 1481, 1519, 1520, 1528,
1529, 1531, 1533-1540, 1543, 1556, 1575,
1594, 1597, 1622, 1629, 1635, 1637, 1676,
1683, 1684, 1689, 1713, 1725, 1727, 1777,
1793, 1807-1809, 1816, 1876, 1897, 1924,
1925, 1930, 1932, 1934-1941, 1944, 1946-1949,
1954, 1955, 1971, 1987, 2014, 2083, 2126,
2127, 2167-2178, 2180-2194, 2197, 2199, 2200,
2206, 2210, 2212, 2217-2221, 2233, 2235-2245,
2247, 2253, 2256, 2259, 2262, 2276, 2278,
2298, 2331, 2336, 2394, 2396, 2406, 2430,
2445, 2447-2455, 2458-2464, 2466, 2467, 2469-
2472, 2474-2481, 2484-2487, 2490, 2491, 2493,
2510, 2566, 2567, 2571-2580, 2590, 2628-2630,
2634-2637, 2639, 2641, 2643, 2645-2650, 2652,
2655-2661, 2675, 2678-2681, 2699, 2712-2714,
2716, 2718, 2724, 2785, 2804, 2805, 2808,
2821, 2852-2858, 2879, 2882, 2883, 2891,
2892, 2896, 2919-2921, 2936, 2949, 2985,
3019, 3023-3027, 3029-3031, 3044-3048, 3083,
3104, 3185, 3188, 3190, 3209, 3242, 3285-
3288, 3318, 3324, 3337, 3338, 3350, 3383-
3385, 3421-3423, 3432, 3462, 3495, 3545,

- 3546, 3549, 3575, 3576, 3578, 3594, 3600, 3617, 3619-3621, 3663, 3673, 3674, 3680, 3681, 3734, 3736, 3741, 3745, 3746, 3774, 3775, 3777, 3782, 3791-3798, 3804, 3860, 3969, 3979, 3980, 3982, 3985, 3988, 3990-3998, 4000, 4008, 4020, 4035, 4036, 4039, 4041, 4048, 4049, 4051, 4066-4075, 4077-4090, 4092-4104, 4106, 4130, 4134, 4162, 4164, 4186, 4242, 4257-4260, 4273-4275, 4278, 4304, 4305, 4309, 4310, 4318
- New Hampshire** 1, 45, 46, 76, 77, 172, 173, 398, 471, 556, 558, 652, 886, 887, 969, 1132, 1971, 2121-2123, 2155-2157, 2254, 2708, 3032, 3265, 3376, 3379-3381, 3399, 3432, 3527, 3528, 3813, 4022, 4035, 4036, 4041, 4043
- New Jersey** 1403
- New Mexico** 2-7, 230, 345, 547, 573, 745-747, 755, 925, 1711, 2076, 2077, 2086, 2097, 2099, 2150, 2387, 2439, 2839-2842, 2890, 2963-2965, 3017, 3111, 3140, 3156-3162, 3274-3279, 3587-3589, 3593, 3604, 3606, 3676-3679, 3693-3702, 3904, 3905, 3917, 4040, 4283
- New York** 1, 45, 46, 76, 77, 368, 556, 558, 652, 779, 1118-1120, 1122, 1123, 1148, 1149, 1447, 1448, 1827, 1828, 2155-2157, 2254, 2409, 2705, 2708, 3399, 3887, 4035, 4036, 4041, 4043, 4302
- Newfoundland** 1, 45, 46, 82, 156, 183-185, 187-189, 456, 569, 586, 621, 626, 673, 720, 721, 731-737, 780-791, 896, 897, 964, 1079, 1081-1083, 1113, 1173, 1212, 1213, 1353-1356, 1526, 1543, 1557, 1776, 2088, 2089, 2420, 2468, 2490, 2514, 2558, 2559, 2561, 2564, 2565, 2578, 2590-2592, 2689, 2690, 2692, 2721, 2794-2796, 2798, 2800, 2852, 2923, 2990, 2994-3002, 3018, 3024-3027, 3031, 3049, 3105, 3308-3310, 3324, 3432, 3804, 3965, 4026, 4027
- nicotine sulfate** 1385
- nitrogen** 517, 747, 1139, 1142, 1144, 2555, 2556, 3340
- nomenclature** 2494, 2933, 4018
- nonhost trees** 416, 426, 435, 442, 4181
- nontarget organisms** 97, 108, 120, 123, 174, 181, 211, 242, 297, 305, 365, 406, 420, 443, 463, 487, 490, 507, 532, 550, 564, 578, 580-582, 584-586, 588-598, 619, 622-625, 726, 738, 742, 866, 867, 885, 976, 997, 1007, 1018, 1019, 1043, 1048, 1054, 1063, 1064, 1115, 1118, 1126, 1146, 1151, 1153, 1162, 1163, 1166, 1173, 1211-1213, 1273, 1278, 1288, 1289, 1299, 1301, 1303, 1304, 1306, 1315, 1318, 1325, 1327, 1329, 1337, 1339, 1370, 1377, 1409, 1410, 1416, 1418, 1446, 1448, 1476, 1512, 1520, 1559, 1565-1567, 1640, 1691, 1692, 1699, 1709, 1724, 1745, 1783, 1785-1787, 1790-1792, 1801, 1863, 1878, 1919, 1949, 1954, 1956, 1988, 2070, 2071, 2074, 2106, 2114, 2166, 2172, 2174, 2178-2181, 2197, 2265, 2394-2396, 2400, 2415, 2416, 2418, 2443, 2444, 2488, 2491, 2510, 2515, 2590, 2599, 2607, 2622, 2685, 2702, 2706, 2707, 2709, 2710, 2712, 2718, 2721, 2737, 2740, 2743, 2745, 2755, 2769, 2774, 2787, 2798-2800, 2804, 2834, 2839-2841, 2845, 2853-2857, 2894, 2895, 2916, 2920, 2921, 2942, 2952, 2961, 2962, 2986, 3029, 3065, 3073, 3092, 3191, 3197, 3209, 3222, 3274, 3280, 3314, 3318, 3374, 3405, 3408, 3479, 3549, 3567, 3600, 3610, 3681, 3682, 3690, 3705, 3730, 3777, 3826, 3842, 3892, 3896, 3900, 3910, 3931, 3945, 3952, 3963, 3980, 3982-3985, 3987-3990, 3992, 3993, 4010, 4069, 4070, 4074, 4097, 4182, 4183, 4258-4260, 4278, 4292, 4314
- nonyl phenol** 1153, 1216
- North America** 1545, 1794, 1817, 3983
- North Dakota** 766, 770, 1026, 1561, 1822, 3145, 3684, 3838, 3845
- northern parula** 1817
- northern white-cedar** 1394, 2345, 2925
- Northwest Territories** 546, 751, 1695, 1696, 1816, 1830, 2562, 2563, 2899, 2901, 3141-3143, 3828, 3829

Norway spruce 1744, 3062, 3255, 4159

Nova Scotia 183-185, 187-189, 202, 250, 262,
673, 675, 740, 897, 964, 1113, 1198-1200,
1354, 1356-1359, 1642, 1643, 1795, 1816,
1877, 1894, 1902, 1926-1928, 1931, 1932,
1938, 1941, 1944, 1946, 2161-2165, 2202-2204,
2206, 2208, 2211-2213, 2217, 2218, 2222,
2233, 2236-2245, 2331, 2429, 2571-2581, 2590-
2592, 2629, 2753, 2754, 2756-2758, 2789,
2791, 2792, 2877-2881, 2906-2911, 3018, 3023,
3024, 3031, 3208, 3286, 3324, 3432, 3511,
3512, 3514-3518, 3599, 3619, 3656, 3663,
3750, 3782, 3966-3968, 4010, 4106, 4110,
4165, 4242, 4277

nuclear polyhedrosis viruses 141, 142, 144-146,
387, 393, 394, 396, 591, 595, 612, 637, 727,
901, 902, 904, 906-911, 913-915, 1257, 1644,
1700, 1710, 1760, 1770, 1794, 1889, 1890,
2270, 2301, 2422, 2515, 2598, 2600, 2601,
2603, 2604, 2612, 2613, 2618, 2621, 2624,
3038, 3064, 3164, 3330, 3368, 3446, 3556-
3558, 3563, 3565, 3566, 3592, 3963

numerical responses 52, 2324, 2454, 2566, 2639,
2656, 2667, 3261, 4312

nun moth 194

nurseries 940, 3684

nursery pine sawfly 2374

nutrient cycling 2325, 2924

nutrition 368, 438, 448, 466, 517, 953, 1141,
1144, 1314, 1603, 1604, 1610, 1671, 1736,
1739, 1829, 1951, 2067, 2069, 2226, 2384,
2828, 2941, 3017, 3283, 3335, 3337, 3340,
3341, 4119, 4129

oak looper 2374

obliquebanded leafroller 931, 2956

Odonata 3832

Ohio 3866

olive-backed thrush 2567

onlined larch sawfly 1813

Ontario 29, 92-94, 98, 101, 108, 110, 112, 115,
117, 122, 131-137, 147, 155, 157, 160, 168-170,
218, 223, 243, 245-250, 317, 318, 320, 375,
376, 393, 416, 422, 428, 435, 437, 447, 448,
451, 466, 511, 519, 520, 529-531, 543, 553,
554, 582, 588, 591, 595, 600, 612-617, 634,
649, 672, 673, 681, 682, 691, 721, 722, 726-
728, 823, 829-833, 878, 897, 900, 903, 905,
906, 908, 909, 911-913, 915, 972, 994, 1097,
1101, 1103, 1113, 1133, 1139, 1141, 1188-
1190, 1192, 1206, 1221, 1222, 1300, 1345,
1346, 1375, 1376, 1409, 1410, 1420-1425,
1436-1439, 1450, 1454, 1477, 1478, 1527,
1543, 1558, 1575, 1598, 1601, 1609, 1611,
1630, 1632, 1633, 1650, 1669, 1670, 1680,
1683, 1737, 1750, 1755-1773, 1796, 1797,
1816, 1824, 1878, 1890, 1901, 1919, 1920,
1954, 2061, 2068, 2074, 2079, 2091-2094,
2122, 2130, 2166, 2198, 2206, 2218, 2224,
2227-2229, 2315, 2328, 2361, 2372, 2373,
2376, 2413, 2419, 2421-2423, 2449, 2487,
2490, 2494, 2590-2594, 2597, 2602, 2604,
2612, 2614, 2615, 2619, 2705, 2725, 2743,
2774-2776, 2786, 2825, 2830, 2885, 2937,
2941, 2944-2948, 2950, 2954, 3035-3037, 3065,
3066, 3074, 3089, 3092, 3144, 3167-3175,
3206, 3207, 3210-3212, 3215-3217, 3220, 3221,
3227, 3228, 3231-3234, 3236, 3239, 3240,
3243, 3247, 3254, 3255, 3258, 3260, 3261,
3329, 3383, 3385, 3424, 3432, 3434-3439,
3505, 3508, 3561, 3562, 3572, 3607, 3620,
3641, 3658-3661, 3663, 3748, 3762, 3763,
3767, 3768, 3770-3772, 3780, 3786, 3827,
3831, 3853, 3860, 3964, 4017, 4058, 4059,
4111-4117, 4122, 4126, 4133, 4134, 4137,
4138, 4157, 4171, 4172, 4187, 4193, 4196-
4199, 4206-4210, 4235, 4312

operation recorders 1439, 1659, 1812, 3441

Oregon 80, 86, 87, 116, 123, 126, 130, 211, 313,
528, 543, 574, 577, 601-604, 653, 657, 663,
666, 706, 708-712, 714, 715, 807, 847, 866-868,
893, 931-933, 965, 1096, 1147, 1403, 1413,

- 1414, 1492, 1723, 1753, 1812, 1843, 1903,
1904, 1906, 1913, 1921, 1961, 1999, 2084-
2087, 2095, 2096, 2344, 2432, 2437, 2440,
2696, 2697, 2749-2752, 2773, 2777-2779, 2893,
2897, 2932, 3140, 3145, 3249, 3539, 3547,
3548, 3551, 3592, 3632, 3787, 3788, 3790,
3863, 3900, 4004-4007, 4009, 4011, 4040,
4055, 4056, 4148-4153, 4155, 4156, 4175,
4176, 4178, 4184, 4280, 4297, 4298, 4300
- organochlorides 1303, 2737, 3121, 3122, 3321
- organophosphates 417, 518, 586, 589, 625, 1191,
1303, 1409, 1410, 1708, 2046, 2336, 2605,
2609, 2610, 2737, 3121, 3122, 3135, 3990
- orientation 161, 1164, 4129, 4133, 4136, 4220
- ornamentals 81, 171, 397, 400, 553, 685, 779,
940, 1859, 2764, 3048, 3513, 3661, 3664, 4158
- orthodichlorobenzene 130
- Orthoptera 539, 614, 615
- outbreak prevention 1447, 1704, 3987
- outbreaks 285, 363, 364, 412, 413, 419, 433, 434,
445, 449, 452, 1573-1575, 1579, 1586, 1904,
1906, 1913, 1914, 1950, 2074, 2116, 2130,
2181, 2197, 2304, 2454, 2457, 2465, 2479,
2487, 2489, 2490, 2566, 2629, 2635, 2652,
2656, 2658, 2667, 2677, 2817, 2863, 2866,
2873, 2890, 2917, 2941-2943, 2945, 2995,
3026, 3027, 3030, 3033, 3047, 3170-3173,
3188, 3189, 3204, 3259-3261, 3359, 3365,
3389, 3434, 3439, 3440, 3583, 3593, 3594,
3599, 3617, 3621, 3662, 3665, 3670, 3673,
3674, 3747, 3758, 3792, 3793, 3796, 3969,
3987, 4039, 4073, 4074, 4077, 4080, 4083,
4085, 4092, 4099, 4105, 4122, 4132, 4134,
4152, 4153, 4175, 4184, 4274, 4312, 4317
- overstory 275, 1424, 1425, 1450, 1451, 1585, 3372
- overwintering larvae 275, 276, 368, 394, 418,
427, 466, 556, 699, 866, 1073, 1074, 1086,
1101, 1119, 1123, 1287, 1399, 1440, 1530,
1547, 1585, 1602, 1616, 1656, 1679, 1826,
1828, 1859, 2057, 2069, 2074, 2080, 2192,
2352, 2368, 2380, 2398, 2448, 2456, 2457,
2469, 2474, 2475, 2477, 2482, 2559, 2564,
2643, 2983, 3147, 3367, 3403, 3530, 3544,
3579, 3590, 3613, 3655, 3722, 3723, 3727,
3732, 3738, 3767, 3808-3812, 3835, 4125,
4155, 4280
- overwintering larval mortality 42, 1123, 1157,
1600, 1828, 2130, 3579
- overwintering larval sampling 739, 1116, 1157,
2006, 2380, 2475, 2477, 2482, 3147, 3514,
3544, 3802, 3805, 3807
- ovicide 1241, 1242, 2149, 3068, 3072
- oviposition 368, 400, 951, 1241, 1242, 1296, 1499,
1506, 1535, 1547, 1602, 1656, 1689, 1828,
1911, 2029, 2368, 2376, 2449, 2452, 2455,
2457, 2472, 2491, 2593, 2599, 2607, 2609,
2612, 2677, 2820, 3035, 3062, 3105, 3250,
3256, 3552, 3559, 3590, 3610, 3742, 3833,
4217, 4219-4221, 4224
- oviposition preferences 466, 1535
- oviposition sites 448, 3656, 4217, 4221, 4224
- oviposition stimulants 3552
- oxidation 3108, 3109
- oxydemeton-methyl 2115, 3007, 3015, 3016
- Pacific silver fir 13
- pales weevil 194, 921
- paper birch 29, 894, 1394, 1657, 1756, 2345,
2420, 2558, 2858, 4161
- parasite alternate hosts 430, 1741, 1748, 1916,
2378, 2455, 2716, 3030, 3046, 3561, 4317
- parasite behavior 2378, 2462

- parasite biology 160, 531, 554, 555, 699, 829-833,
 1194, 1320, 1655, 1741, 2315, 2328, 2375,
 2378, 2487, 2523, 2688, 3045, 3165, 3301,
 3398, 3747, 3764, 3766, 4018, 4019, 4315, 4317
- parasite density 443, 711, 1074, 2070, 2462,
 3030, 3405, 4173
- parasite detection 744, 3773
- parasite development 1739, 2051, 2451, 2523,
 2805, 3378
- parasite diversity 443, 4315
- parasite eggs 2063, 2378
- parasite emergence 1194, 2523
- parasite fecundity 2062, 2063
- parasite feeding 2063
- parasite host acceptance 2844, 3833
- parasite host density 2451, 2462, 2486, 2658,
 3030, 3747, 3972
- parasite host development 2375, 2805
- parasite host preferences 2080, 2523, 4315
- parasite host specificity 3046
- parasite identifications 829-833, 835, 3779
- parasite introductions 76, 77, 92, 110, 178, 203,
 574, 643, 728, 792, 829, 831, 832, 836, 899,
 976, 1100, 1106, 1122, 1399, 1741, 1747, 2051,
 2063, 2072, 2254, 2256-2259, 2314, 2421,
 2489, 2512, 2513, 2825, 2870, 3045, 3662,
 3751, 3792, 3794, 4171-4173
- parasite larvae 2378, 3779
- parasite longevity 2063
- parasite morphology 160, 835, 2316, 2328, 2462,
 2886, 3375, 4223
- parasite mortality 4317
- parasite physiology 2063, 2462
- parasite pupae 2523, 3779
- parasite rearing 728, 830, 836, 1735-1737, 1739,
 1751, 3378, 4171, 4173
- parasite reproduction 4317
- parasite sex ratios 2375
- parasite weight 2523
- parasites 42, 47, 53, 62, 65, 71, 76, 77, 85, 92, 96,
 110, 112, 124, 128, 156, 160, 178, 190, 200,
 209, 216, 287, 290, 293, 299, 302, 305, 316,
 322, 334, 403, 404, 406-408, 419, 427, 430,
 436, 437, 439, 443, 457, 462, 464, 482, 486,
 487, 511, 531, 554-556, 558, 563, 564, 571,
 573-575, 610, 613, 679, 690, 699, 707, 711,
 712, 714, 715, 737, 755, 766, 783, 784, 786-
 788, 792, 812, 829, 832-834, 836, 837, 859,
 860, 863, 866-868, 896, 899, 940, 942, 957,
 974, 976, 996, 1002, 1007, 1021, 1073, 1074,
 1081, 1087, 1090, 1100, 1103, 1106, 1110,
 1115, 1118, 1122, 1123, 1125, 1138, 1194,
 1257, 1279, 1286, 1314, 1349, 1351, 1357,
 1384, 1388, 1399, 1422, 1437, 1440, 1470,
 1485, 1502, 1527, 1554, 1559, 1568, 1569,
 1590, 1609, 1640, 1650, 1655, 1699, 1718,
 1731, 1732, 1735-1740, 1743-1746, 1748, 1752,
 1756, 1813, 1827, 1850, 1859, 1869, 1882,
 1885, 1908, 1910, 1915, 1916, 1961, 1986,
 2012, 2030, 2033, 2042, 2055, 2062, 2064,
 2070, 2071, 2080, 2089, 2093, 2104, 2107,
 2159, 2169, 2172, 2178, 2190, 2191, 2194,
 2197, 2253-2256, 2258-2264, 2316, 2319, 2328,
 2366, 2368, 2370, 2372-2376, 2383, 2385,
 2388, 2389, 2398, 2414, 2416, 2434, 2439,
 2448, 2451, 2454, 2455, 2462, 2463, 2479,
 2486, 2489, 2491, 2511, 2523, 2595, 2599,
 2610, 2613, 2652, 2658, 2688, 2691, 2707,
 2716, 2718, 2745, 2760, 2794, 2796, 2798-
 2800, 2805, 2840, 2842, 2844, 2870, 2886,
 2934, 2943, 2946, 2999, 3030, 3043, 3045,
 3046, 3064, 3101, 3103, 3165, 3174, 3181,

- 3182, 3211, 3274, 3275, 3301, 3310, 3318, 3329, 3367, 3375, 3389, 3398, 3403, 3405, 3408, 3442, 3458, 3533, 3535, 3561, 3562, 3590, 3602, 3656, 3670, 3687, 3711, 3728, 3747, 3751, 3760, 3761, 3766, 3773, 3779, 3792, 3794, 3809, 3833, 3842, 3851, 3891, 3901, 3958, 3981, 3983, 3985, 3987, 3989, 3992, 3993, 3999, 4017-4019, 4049, 4052, 4071, 4091, 4097, 4156, 4166, 4167, 4172, 4173, 4179, 4180, 4183, 4189, 4194, 4195, 4198-4201, 4203, 4206, 4214, 4235, 4294, 4315-4317
- parasitism 53, 62, 216, 299, 334, 407, 430, 443, 462, 464, 482, 486, 699, 707, 711, 712, 744, 756, 812, 863, 868, 941, 953, 1025, 1053, 1078, 1086, 1118, 1122, 1123, 1173, 1309, 1314, 1357, 1366, 1399, 1420, 1559, 1568, 1590, 1609, 1743, 1826, 1869, 1915, 2002, 2042, 2070-2072, 2080, 2178, 2185, 2191, 2251, 2260, 2383, 2384, 2398, 2434, 2439, 2451, 2454, 2455, 2460, 2462, 2463, 2467, 2486, 2487, 2587, 2599, 2609, 2612, 2613, 2652, 2706, 2716, 2799, 2800, 2840, 2997, 3012, 3103, 3246, 3275, 3318, 3338, 3344, 3392, 3398, 3403, 3408, 3561, 3707, 3709, 3714, 3715, 3722, 3833, 3842, 3992, 3993, 4051, 4167, 4172, 4173, 4180, 4183, 4188, 4196, 4261, 4264, 4315, 4317
- parasitism rate 523, 1589, 1850, 2998, 2999, 3277, 3398, 3408, 3631, 3690, 3787, 3790, 3808-3812
- parathion 1708
- pathogen biology 1135, 1493, 1494, 3760, 3761, 4213
- pathogen identification 3972, 4199
- pathogen morphology 143, 903, 3769, 4192, 4199
- pathogen/biochemical combinations 4064
- pathogen/chemical combinations 488, 912, 988, 1038, 1347, 1760, 1891, 2598-2600, 2605, 2607-2613, 2625
- pathogen/parasite interactions 1609, 3766
- pathogenicity 387, 390, 907-909, 1370, 2034, 2125, 3449, 3450, 3465, 3469, 3491, 3780, 4188, 4197, 4290
- pathogens 69, 71-73, 124, 139, 140, 360-362, 384-386, 389, 390, 392-396, 437, 488, 575, 613-617, 638, 639, 679, 690, 694, 788, 837, 838, 908, 909, 961, 1137, 1257, 1286, 1388, 1399, 1652, 1653, 1756, 1813, 2104, 2270, 2374, 2389, 2434, 2489, 2493, 2538, 2603, 2612, 2618, 2621, 2625, 2739, 2794, 2798, 3018, 3031, 3443, 3446, 3449, 3453, 3458-3460, 3465, 3466, 3469-3472, 3476, 3477, 3482, 3485, 3487, 3560, 3563, 3565, 3784, 3972-3975, 3987, 4187, 4188, 4197, 4207, 4208, 4211-4213
- penfluron 3075
- Pennsylvania 107, 543, 1403, 2708, 2717, 4042
- Pentatomidae 2197, 3993
- permethrin 153, 980, 982, 1641, 1662, 1955, 2015, 2290, 2718, 3123, 3124, 3132, 3135, 3136, 3344, 4318
- persistence 2599, 2952, 2980, 3005, 3009, 3131, 3560, 3991, 4310
- perturbations 1419, 2399, 3185, 3189, 3408, 3472
- pest conditions 54-59, 61, 63-66, 82, 95, 131-137, 175, 179, 180, 197, 202-208, 218, 225, 286, 333, 348, 349, 375, 376, 484, 495, 521, 525-527, 529, 530, 534-537, 541, 570, 571, 669, 670, 672-674, 682, 686-689, 691, 720, 721, 753, 754, 766, 770, 779-791, 795-799, 803, 823, 845, 846, 851-854, 856, 857, 937, 939, 959, 974, 1003, 1024, 1026, 1084, 1085, 1092-1095, 1109-1111, 1133, 1134, 1189, 1201, 1214, 1215, 1221-1239, 1244-1253, 1255, 1307, 1310, 1311, 1357-1359, 1375, 1414, 1436, 1440, 1466, 1467, 1472, 1473, 1480, 1492, 1522, 1533, 1558, 1561, 1664, 1677, 1678, 1680-1684, 1695, 1696, 1703, 1706, 1722, 1723, 1757-1759, 1764-1769, 1772, 1773, 1796, 1797, 1814, 1822, 1823, 1860, 1862, 1865-1868, 1928, 1930, 1931, 1933, 1942, 1946, 1962,

- 1963, 1968, 1969, 1982, 1983, 1989-1994, 1996-1998, 2001-2005, 2020, 2023-2025, 2047, 2075, 2111, 2117-2119, 2155, 2157, 2161-2165, 2198, 2202-2204, 2227-2229, 2233-2245, 2267, 2358, 2362, 2367, 2370, 2371, 2423, 2429, 2430, 2432, 2501, 2537, 2538, 2562, 2563, 2568, 2571-2580, 2584-2589, 2668-2673, 2687, 2758, 2780-2782, 2784, 2815, 2836-2838, 2843, 2849-2851, 2868, 2872, 2874, 2880, 2881, 2899-2902, 2940, 2971, 3026, 3027, 3050-3061, 3102, 3141-3143, 3145, 3168-3173, 3193, 3200-3203, 3206, 3207, 3310, 3312, 3331, 3435, 3437, 3438, 3441, 3515, 3518, 3596-3598, 3664, 3667, 3692, 3703, 3704, 3716, 3725, 3733, 3770-3772, 3782, 3784, 3785, 3796, 3828, 3829, 3834, 3836, 3837, 3839, 3844-3847, 3850, 3851, 3860, 3861, 3864-3867, 3873, 3874, 3876, 3893, 3894, 3918-3920, 3947, 3961, 4026, 4030, 4035, 4036, 4041-4043, 4111-4117, 4147, 4148, 4228-4234, 4253-4256, 4261, 4262, 4264-4272, 4285, 4287
- phenology 289, 313, 341, 425, 438, 448, 466, 635, 740, 1281, 1564, 1565, 1903, 2191, 2458, 2460, 2469, 2518, 2769, 2785, 3034, 3254, 3354, 3371, 3510, 3656, 3663, 3856, 4049, 4081, 4082
- phenothrin 3121
- phenotypes 3581, 3582, 3585, 4007
- pheromone blends 35, 1833, 3237, 3257
- pheromone gland 1131, 3213, 3223, 3251, 4062
- pheromone identification 931, 1131, 1525, 1819, 3383, 3385, 3388, 4057
- pheromone inhibitors 3247, 4057, 4061
- pheromone isomers 931, 1525, 1833, 2201, 3216, 3383, 3388, 4063
- pheromone production 2887, 3251, 4062
- pheromone receptors 22-24, 3317
- pheromone release rate 36, 37, 933, 2086, 2664, 2976, 3217, 3251, 3383, 4005
- pheromone specificity 2086, 2087, 3213, 3238, 4005
- pheromone synthesis 1819, 2665, 2887
- pheromone-baited trap catches 45, 46, 49, 1746, 1832, 1900, 2019, 2879, 2977, 3213, 3215, 3222, 3239, 3257, 3384, 3413, 3536, 3932, 4185
- pheromone-baited trap design 46, 68, 1857, 2483, 3222, 3230, 3239, 3240, 3244, 3373, 3907, 3944, 4058
- pheromone-baited trap placement 1, 45, 46, 49, 1832, 2084, 3239, 3244
- pheromone-baited traps 1, 43, 44, 46, 48, 50, 59, 115, 383, 752, 930, 932, 935, 1092-1094, 1206, 1280, 1309, 1718, 1750, 1774, 1832, 1833, 1857, 1900, 1918, 2149, 2480, 2483, 2636, 2808, 2879, 2975, 2977, 3183, 3215, 3222, 3227, 3230-3233, 3235, 3239, 3240, 3244-3247, 3257, 3258, 3266, 3267, 3360, 3361, 3683, 4058, 4065, 4267
- pheromones 1, 22-24, 35-38, 88, 115, 156, 383, 420, 487, 611, 636, 679, 680, 694, 737, 768, 818, 837, 899, 930-936, 1047, 1131, 1257, 1280, 1316, 1317, 1401, 1427, 1521, 1525, 1527, 1606, 1608, 1644, 1742, 1743, 1745, 1750, 1798, 1803, 1819, 1833, 1882, 1918, 2035, 2083, 2084, 2086, 2149, 2196, 2201, 2265, 2389, 2424-2428, 2465, 2483, 2489, 2664, 2665, 2745, 2798, 2808, 2820-2824, 2884, 2887, 2888, 2956, 2975, 3064, 3148, 3183, 3184, 3210, 3212-3219, 3223, 3225-3227, 3229, 3231-3233, 3235-3238, 3241, 3245, 3247-3249, 3251-3254, 3257, 3258, 3285-3289, 3295, 3317, 3360, 3361, 3384-3388, 3572, 3650, 3683, 3684, 3741, 3886, 3987, 4057-4065, 4162, 4163, 4292
- phorate 992
- phosmet 153, 305, 987, 1275, 1639, 2115, 2290, 2291, 3124, 3135, 3344, 3408
- phosphamidon 153, 156, 337, 584, 588, 589, 782, 992, 1010, 1012, 1126, 1159, 1173, 1275, 1306,

- 1318, 1377, 1519, 1528, 1808, 1934, 1937, 1939, 1945, 1954, 1956, 2167, 2172, 2175, 2176, 2193, 2195, 2200, 2396, 2488, 2491, 2712, 2740, 2743, 2852, 2856, 2857, 2883, 2952, 2980, 2991, 3334, 3549, 3609, 3705, 3742, 3979, 3980, 3984, 3988, 3992, 3994, 4008, 4010, 4026
- photogrammetry 2654, 4139
- photoperiod 1605, 1614, 1616, 3213, 3223, 3224, 3226, 3250, 3251
- photosynthesis 774, 775
- phoxim 153, 1730, 2728, 2737, 2746
- physiography 2433
- phytotoxicity 1148
- pin cherry 29, 2345, 3996
- pine bark adelgid 2374
- pine beauty moth 914, 2956
- pine butterfly 767, 805, 1416, 4178
- pine needle sheathminer 700
- pine root collar weevil 337, 4222
- pine sawflies 4140
- pine shoot borer 2956
- pine shoot moths 194
- pine siskin 2279
- pine tortoise scale 337
- pine tortrix 75, 3603, 3604, 3646
- pine tussock moth 326, 336-338
- pine webworm 4279
- pinon 3677
- pitfall traps 1742, 1743, 1749, 1901, 3032, 3927, 3990
- planning 372, 893, 1068, 2209, 2296, 2786, 3325, 3328, 3411, 3857, 3964, 4146
- plant growth hormones 1174-1176
- plantations 137, 264, 397, 568, 697, 987, 988, 1366, 2030, 2746, 2764, 4222, 4279
- Plecoptera 1166, 1523, 1621, 2519, 3405, 3817, 3819, 3821, 3823
- poison dusts 3656, 3663
- Poland 482, 1428, 2956
- polarized light 4123, 4136
- pole blight 1554
- pole pruners 2386, 2644, 2674
- pole-pruner basket 978, 2674, 3933
- pollen 368, 448, 1426, 1828, 2069, 2457, 2858, 2921, 3103
- pollination 1567, 2443, 2919, 3280, 3734, 4259, 4260
- pollinators 591, 1173, 1565-1567, 1949, 2395, 2410, 2709, 2718, 2745, 2769, 2787, 2919-2921, 2952, 3734, 3984, 3989, 3990, 4257-4259, 4293
- polyandry 2808
- polygamy 2802
- polygyny 648
- polyhedrosis viruses 389, 390, 640, 905, 3560, 4121
- polymorphism 3282, 3283, 3580-3582, 3584, 3633

ponderosa pine 287, 370, 606, 704, 705, 934, 996,
1028-1030, 1157, 1219, 1551, 2293, 3162,
3205, 3539, 3571, 3602-3604, 3646, 3676-3679,
3685

population 302, 551, 757, 815, 825, 862, 960, 978,
1028, 1058, 1732, 1819, 1917, 2251, 2453,
3026, 3027, 3222, 3400, 3422, 3567, 3721,
3722, 3727, 3835, 3969

population density 2-4, 171, 180, 192, 209, 256,
275, 290, 298, 301-303, 466, 484, 544, 600,
653, 661, 665, 669, 714, 737, 786, 825, 887,
896, 975, 978, 980, 989, 1000, 1073, 1074,
1273, 1308, 1375, 1383, 1423, 1482, 1532,
1536, 1558, 1583-1585, 1664, 1732, 1768,
1875, 1880, 1944, 1946, 1962, 1963, 1968,
1969, 1983, 1984, 1991-1994, 2000, 2013,
2047, 2077, 2117, 2118, 2180, 2181, 2191,
2197, 2238, 2239, 2319, 2326, 2384, 2388,
2434, 2442, 2447, 2451, 2454, 2474, 2478-
2481, 2483-2486, 2497, 2574, 2576, 2577,
2593, 2599, 2600, 2613, 2630, 2631, 2634,
2636, 2638, 2641, 2647, 2648, 2651, 2652,
2656-2658, 2660, 2666, 2674, 2675, 2679,
2687, 2835-2838, 2843, 2865, 2868, 2869,
2873, 2924, 2930, 2936, 2953, 2954, 2978,
2985, 3025, 3027, 3046, 3049, 3103, 3179,
3189, 3222, 3251, 3259, 3261, 3365, 3369,
3389, 3391, 3400-3402, 3405, 3410, 3418,
3442, 3477, 3486, 3487, 3506, 3562, 3567,
3583, 3587, 3611, 3638, 3649, 3681, 3698,
3699, 3702, 3721, 3722, 3770, 3783, 3864,
3873, 3874, 3969, 3990, 4021, 4028, 4031-
4033, 4053, 4081, 4109, 4124, 4132, 4152,
4166, 4167, 4180, 4181

population dynamics 363, 434, 445, 463, 551,
552, 649, 650, 664, 669, 707, 716, 743, 802,
837, 898, 1173, 1302, 1323, 1331-1334, 1336,
1349, 1351, 1482, 1495, 1530, 1531, 1535-
1537, 1580, 1598, 1602, 1742, 1907, 2126,
2156, 2184-2192, 2197, 2321, 2326, 2383,
2384, 2388, 2414, 2416, 2451, 2454, 2458-
2460, 2466, 2516, 2548, 2554, 2561, 2566,
2631, 2633, 2634, 2637, 2639-2641, 2643,
2645-2648, 2651, 2656-2658, 2660, 2675, 2677-
2679, 2714, 2716, 2891, 2892, 2939, 3044,

3179, 3185, 3187-3189, 3228, 3234, 3261,
3338, 3340, 3389, 3434, 3563, 3689, 3758,
3790, 3977, 3990, 4020, 4040, 4048, 4049,
4052-4054, 4089

population fluctuations 25, 41, 54-59, 63-66, 102,
225, 322, 329, 331, 399, 405, 410, 411, 417,
418, 425, 427, 430, 435, 440-442, 446, 447,
456, 459, 462, 463, 465, 557, 572, 573, 604,
669, 674, 686, 711, 712, 721, 735, 755, 756,
776, 777, 805, 806, 851-856, 859, 860, 863,
904, 956, 989, 1001-1003, 1005, 1006, 1091-
1094, 1096, 1119, 1188, 1192, 1215, 1223-
1225, 1229-1233, 1235-1238, 1244-1248, 1251-
1253, 1281, 1300, 1309, 1314, 1351, 1412,
1414, 1420, 1426, 1430, 1436, 1437, 1447,
1454, 1486, 1499, 1502, 1503, 1507, 1522,
1533, 1534, 1538, 1539, 1645, 1658, 1704,
1759, 1762, 1763, 1813, 1818, 1866, 1867,
1871, 1872, 1874, 1910, 1920, 1926, 1927,
1939, 1961, 2042, 2068, 2077, 2240, 2253,
2254, 2256-2260, 2262, 2304, 2307, 2342,
2373, 2384, 2388, 2434, 2439, 2447, 2449,
2451, 2452, 2457, 2465, 2483, 2486, 2487,
2497, 2584-2588, 2629, 2651, 2652, 2667,
2695, 2796-2798, 2868, 2869, 2873, 2917,
2924, 2930, 2936, 2946, 2953, 2954, 2978,
2998, 3027, 3030, 3047, 3170, 3171, 3179,
3182, 3190, 3204, 3259, 3354, 3364, 3365,
3370, 3389, 3391, 3442, 3583, 3669, 3670,
3673, 3681, 3714, 3716, 3719, 3720, 3748,
3752, 3783, 3792, 3796, 3855, 3860, 3867,
3958, 3961, 3981, 4031, 4032, 4072, 4074,
4105, 4109, 4124, 4132, 4134, 4152, 4167,
4249, 4262-4267, 4312

population models 608, 743, 773, 776-778, 898,
1323, 1324, 1453, 1546, 1580, 1713, 1714,
1880, 1881, 1907, 1908, 2132, 2184, 2360,
2414, 2462, 2463, 2631, 2640, 2641, 2646,
2647, 2679, 2924, 2936, 3179, 3189, 3377,
3574, 3752, 4020, 4048, 4051-4053

population monitoring 46, 472, 1328, 1984, 2565,
2879, 3222

population quality 1598, 1601, 2122, 2123, 3111,
3140, 3637

- population reductions 412, 414, 415, 417, 419, 430, 436, 564, 568, 588, 599, 651, 712, 815, 827, 862, 864, 908, 909, 911, 938, 941, 951, 968, 991, 992, 999, 1038, 1046, 1052, 1057, 1066, 1088, 1118, 1148, 1281, 1314, 1688, 1724, 1726, 1770, 1771, 1801, 1837, 1878, 1938-1940, 1945, 2022, 2074, 2106, 2179, 2197, 2269, 2272, 2346, 2363, 2417, 2472, 2474, 2505, 2508, 2567, 2593, 2598-2600, 2607-2610, 2613, 2618, 2625, 2653, 2706, 2743, 2804, 2937, 2986, 3306, 3408, 3409, 3486, 3567, 3610, 3658, 3659, 3681, 3813, 3827, 4022, 4037, 4074, 4078, 4080, 4081, 4083-4085, 4152, 4153, 4173, 4182, 4188
- population sampling 190, 270, 323, 568, 635, 710, 751, 815, 1000, 1116, 1583-1585, 1819, 1911, 2027, 2464, 2575, 2578, 2579, 2632, 2657, 3401, 3567, 3732, 4069, 4071, 4101, 4155, 4159
- population trends 45, 48, 49, 56-59, 63, 713, 773, 851, 852, 854, 856, 868, 1076, 1146, 1300, 1314, 1356, 1369, 1388, 1486, 1492, 1509, 1522, 1534, 1539, 1546, 1559, 1578, 1583, 1618, 1763, 1900, 1964, 1965, 2019, 2341, 2434, 2447, 2584, 2586, 2651, 2792, 2898, 3536, 3724, 3729, 4070, 4166, 4167, 4185, 4262, 4264
- precipitation 527, 1669, 1670, 1832, 2130, 2154, 2191, 2247, 2866, 2917, 3338, 4122, 4134
- predation 52, 217, 465, 599, 653, 655, 707, 883, 884, 886, 1314, 1420, 1421, 1431, 1442, 1447, 1667, 1835, 1840, 1851, 1859, 2126, 2127, 2206, 2326, 2383, 2384, 2417, 2457, 2460, 2467, 2532, 2567, 2656, 2716, 3047, 3418, 3442, 3494, 3612, 3685, 3788, 4025, 4137, 4138
- predation rate 659, 887, 1901, 2417, 3047, 3418, 3685
- predator introductions 792, 1319
- predator physiology 2567
- predator/parasite interactions 3442
- predator/prey interactions 599, 3686
- predators 42, 52, 91, 96, 156, 169, 200, 217, 279, 287, 293, 408, 419, 436, 437, 463, 538, 599, 655, 658-662, 664, 673, 690, 714, 783, 792, 837, 884, 887, 889, 899, 1007, 1021, 1054, 1103, 1122-1124, 1279, 1286, 1314, 1351, 1384, 1401, 1421, 1422, 1429, 1437, 1502, 1527, 1640, 1645, 1655, 1699, 1718, 1743, 1745, 1756, 1813, 1835, 1841, 1851, 1853, 1859, 1901, 1986, 2008, 2011, 2055, 2071, 2104, 2107, 2126, 2185, 2194, 2197, 2206, 2279, 2324, 2326, 2368, 2374, 2383, 2388, 2389, 2402, 2414, 2416, 2417, 2457, 2479, 2489, 2491, 2532, 2566, 2567, 2631, 2639, 2655, 2656, 2666, 2667, 2716, 2718, 2745, 2794, 2796, 2798, 3032, 3047, 3064, 3255, 3261, 3332, 3458, 3494, 3611, 3670, 3681, 3686, 3687, 3762, 3789, 3832, 3852, 3868, 3979, 3981, 3985, 3987, 3989, 3992, 3993, 4025, 4071, 4297-4300, 4312
- predictive equations 2387, 2447, 2640, 3402, 3869, 3992, 4090, 4177
- prepupae 2828, 3080, 3313, 4196
- prey density 1431, 2324, 2566, 2656, 3047
- primary productivity 2325, 2924
- Prince Edward Island 183-185, 187, 188, 795-797, 799, 897, 1198, 1199, 1356-1359, 1816, 1929, 1932, 1933, 1944, 1946, 2233, 2236-2245, 2571-2580, 2629, 3024, 3031, 3782
- propoxur 153, 992, 2729, 2737, 3039
- protandry 3281
- protozoa 69, 71, 837, 899, 1137, 1666, 1891, 2270, 2601, 3459, 3760, 4192, 4196, 4202
- pulping 219, 244, 380, 1071, 1291, 1292, 1397, 1445, 1629-1637, 1795, 1877, 1894, 2517
- pulpwood 380, 1071, 1371, 1397, 1445, 1636, 1704, 1721, 1795, 1894, 1902, 1939, 2337, 3663, 4080, 4142, 4307
- pungenin 1675, 3651

- pupae 661, 663, 1514, 1517, 1547, 1559, 1602, 1613, 1656, 1837, 1848, 1859, 1967, 2044, 2104, 2149, 2184, 2315, 2324, 2368, 2375, 2383, 2457, 2460, 2466, 2567, 2645, 2714, 2801, 2803, 2809, 2813, 2828, 2863, 3071, 3073, 3078, 3080, 3081, 3085, 3165, 3224, 3313, 3338, 3487, 3492, 3504, 3565, 3610, 3743, 3762, 3773, 3938, 3972, 3993, 4004, 4017, 4025, 4196, 4215
- pupal cremasters 2324, 2567
- pupal density 551, 1073, 1964, 2253, 2254, 2460, 2567, 3658, 3972
- pupal development 463, 1530, 1656, 2037, 2809, 3034, 3041, 3224, 3744, 3756, 3765, 3767
- pupal morphology 646, 2567
- pupal mortality 425, 439, 567, 1349, 2372, 2467, 2532, 2714, 3073, 3078, 3085, 3565, 3762, 4202
- pupal parasites 299, 486, 575, 925, 1399, 1437, 1589, 2104, 2454, 2609, 2844, 3165, 3398, 3405, 3773, 3787, 3833, 3993, 4017, 4196, 4317
- pupal physiology 11, 12
- pupal sampling 307, 454, 551, 657, 807, 1079, 1348, 1350, 1780, 1915, 2377, 2453, 2549, 2565, 2648, 2674, 2924, 3246, 3550, 3551, 3972, 4215
- pupal sex 1602, 1848
- pupal size 649, 650, 1053, 2186, 2322, 2452, 2458, 2484
- pupal survival 425, 439, 2190, 2460, 2645, 3041
- pupal weight 40, 311, 314, 650, 733, 1169, 1602, 2044, 2123, 2322, 2484, 2556, 2593, 3146, 3336, 3337, 3339, 3767, 4193, 4202
- puparia 2328, 3181
- pupation 384, 387, 395, 400, 543, 953, 1399, 1440, 1547, 1656, 1859, 2069, 2352, 2368, 2460, 2803, 3073, 3088, 3504, 3561, 3565, 3766, 4196
- purple martin 1859
- pyrethrins 153, 542, 605, 1275, 1762, 1995, 2115, 2151, 2526, 2625, 3106, 3121, 3122, 3134, 3269, 3270, 4008, 4292
- pyrethroids 980, 1193, 1726, 2605, 2625, 3121, 3135, 3136, 3334
- quaking aspen 29, 1756, 2345, 3122, 3162, 3357
- Quebec 1, 18, 45, 46, 97, 98, 110, 113, 118, 120, 138, 169, 170, 177, 308, 309, 347-349, 367, 368, 403-414, 416-419, 421, 423, 425-430, 432, 433, 435-444, 446, 450, 453-455, 457-465, 468, 486, 507, 531, 554, 558, 584, 587-589, 592, 595, 598, 721, 752, 819, 834, 848, 878, 880, 881, 892, 897, 900, 937-943, 945-951, 953, 955-962, 968, 972, 978-980, 982, 985, 987, 988, 994, 997, 1009, 1011-1014, 1071, 1098, 1099, 1102, 1103, 1112, 1113, 1115, 1117, 1133, 1210, 1319, 1340, 1342, 1347, 1424, 1425, 1432-1437, 1454, 1470, 1481, 1485, 1539, 1543, 1573, 1575-1578, 1623-1628, 1650, 1676, 1680, 1716, 1729, 1816, 1920, 1952, 1953, 1956, 1957, 2015, 2038, 2054, 2058, 2124, 2206, 2218, 2253-2256, 2259, 2260, 2262, 2264, 2302-2311, 2320, 2336, 2395, 2398, 2401, 2402, 2404, 2409, 2415, 2417, 2431, 2449, 2490, 2520, 2590-2592, 2595, 2616, 2619, 2703-2705, 2723, 2785, 2829, 2831-2833, 2845, 2858, 2875, 2876, 2917, 2925-2928, 2981, 2987-2989, 2992, 3324, 3350, 3351, 3432, 3443, 3445-3447, 3449, 3451, 3455-3458, 3461-3465, 3469-3472, 3475-3477, 3482-3489, 3492, 3493, 3572, 3610, 3658, 3659, 3661, 3663-3665, 3668, 3669, 3671, 3673, 3804, 3860, 3862, 3960, 4035-4037, 4041, 4075, 4085, 4087, 4092, 4105, 4134, 4171, 4187, 4313
- R 20458 3085
- R 34912 3128
- R 51915 3128
- R 52716 3128

R 52717 3128
 R 52858 3128
 R 56572 3128
 radar 1033, 1532, 1540, 1689, 2472, 2973
 radial increment 411, 416, 422, 426, 435, 442, 562, 704, 1188, 1673, 2635, 4134, 4184
 radiation 1206, 3067, 3078
 radiography 2390-2392, 3081, 3773
 radioisotopes 279, 2008, 2037, 2525, 3067, 3078, 4301
 rain 2130, 2858, 3220, 3469, 4132
 raspberry 2345, 3996
 rearing 17, 51, 62, 160, 198, 340, 519, 520, 643, 792, 929, 1000, 1021, 1547-1549, 1599, 1602-1604, 1610, 1655, 1656, 1671, 1740, 1744, 2147, 2376, 2411-2413, 2484, 2489, 2523, 2535, 2714, 2732, 2811, 2993, 3078, 3085, 3113, 3121, 3129, 3224, 3282, 3283, 3335, 3339, 3446, 3453, 3506, 3522, 3561, 3579, 3637, 3722, 3727, 3740, 3743, 4119, 4120, 4194, 4201, 4204, 4213, 4280
 recommendations 632, 633, 739, 1943, 1999, 2099, 2302, 2435-2438, 2440, 2509, 2543, 2626, 2627, 2967-2970, 3013, 3158, 3160, 3433, 3537, 3538, 3626, 3669, 3697, 3859, 4181
 recreation 607, 1376, 2690, 2708, 2936, 3886, 3898, 3908, 3984
 red maple 1657, 2345, 2858, 4309
 red pine 264, 1657, 1744, 2498, 3122, 3619
 red pine sawfly 1813, 1815, 4044
 red ring rot 1393
 red spruce 15, 19, 46, 161, 307, 431, 453, 473, 477-479, 489, 516, 628, 692, 738, 739, 821, 892, 896, 919, 969, 1039, 1322, 1392-1394, 1488, 1531, 1564, 1579, 1596, 1597, 1744, 1777, 1816, 1841, 1929, 1942, 2052, 2209, 2210, 2212, 2216, 2220, 2345, 2405, 2407, 2468, 2506, 2516, 2592, 2684, 2691, 2755, 2858, 3328, 3353, 3376, 3512, 3538, 3541-3543, 3619, 3807, 3933, 3995, 4101, 4110, 4242, 4309
 red squirrel 1124, 1901, 2639, 2656
 red-backed vole 2656
 redheaded jack pine sawfly 1813, 1815
 redheaded pine sawfly 336-338, 914, 1508, 2774
 reforestation 1209, 1433, 2692
 regeneration weevil 1744
 relative humidity 2413, 2460, 3041, 3738, 3972, 4049, 4122, 4132
 remote sensing 164, 308, 576, 767, 769, 1324, 1592, 1593, 1660, 1774, 1824, 1921, 2059, 2230, 2335, 2560, 2582, 2700, 2717, 2770-2772, 2790, 2974, 3145, 3433, 4239, 4240, 4250
 reproduction 517, 567, 647, 648, 650, 706, 2122, 2453, 2661, 2802, 2803, 2806, 2808, 2809, 2812, 2813, 3215, 3247, 3333
 reproductive isolation 647, 1608, 2085, 3213, 3238, 3505-3507, 3510
 reptiles 1048, 1054, 2774, 3104, 3682
 research 252, 472, 476, 619, 693, 696, 1199, 1544, 1888, 1973, 2379, 2489, 2711, 2938, 2942, 2950, 3179, 3570, 3885, 3890
 residual toxicity 2727, 2731, 2735-2737, 2741, 2742, 2744, 3609
 residues 350, 365, 548, 549, 578, 589, 592, 596, 625, 727, 742, 827, 1034, 1035, 1043, 1048,

- 1054, 1063-1065, 1069, 1115, 1150, 1152, 1172, 1179, 1212, 1213, 1216, 1315, 1326, 1370, 1459, 1461-1464, 1471, 1476, 1496, 1497, 1514, 1556, 1699, 1725, 1727, 1770, 1863, 1953, 1972, 1988, 2046, 2074, 2151, 2187, 2192, 2195, 2197, 2250, 2265, 2276, 2277, 2280, 2350, 2395, 2403, 2416, 2418, 2505, 2593, 2702, 2710, 2712, 2721, 2730, 2755, 2793, 2814, 2853, 2858, 2912, 2913, 2952, 2980, 3010, 3014, 3015, 3096, 3100, 3109, 3209, 3315, 3374, 3497, 3573, 3609, 3658, 3681, 3701, 3823, 3871, 3980, 3982, 3994, 4015, 4023, 4158, 4260, 4274, 4275, 4304-4311, 4317
- resmethrin 153, 2605, 2625, 3121
- ronnel 153
- root mortality 114, 3019, 3021, 3621, 4250
- root rots 129, 1776, 2719, 2996, 3621, 4157
- roots 2154, 2719, 3019-3021, 3617, 3618, 3621
- saddleback looper 524, 3357
- saddled prominent 3265
- safety 508, 589, 678, 725, 1212, 1213, 1341, 2114, 2270, 2336, 2644, 2776, 3345, 3525, 3931, 3954-3956, 4156
- salmon 1304, 1783, 1897, 2892, 2942, 2952
- Salticidae 2126, 2127
- salvage cutting 120, 248, 329-331, 380, 382, 405, 411, 473, 619, 644, 794, 840, 842, 843, 879, 895, 916, 971, 972, 1071, 1103, 1115, 1134, 1154, 1291, 1337, 1397, 1445, 1449, 1491, 1554, 1562, 1596, 1618, 1619, 1634, 1636, 1648, 1795, 1803, 1894, 1902, 1976, 2007, 2246, 2249, 2265, 2404, 2406, 2442, 2499, 2517, 2549, 2654, 2695, 2754, 2757, 2818, 2830, 2859, 2893, 2927, 2939, 2941, 3001, 3022, 3195, 3303, 3324, 3382, 3425, 3429-3431, 3675, 3748, 3793, 3859, 3888, 3898, 3921, 3922, 3957, 4010, 4024, 4288
- sample size 1079, 1082, 1584, 2222, 2630, 2648, 3037, 3409, 3726, 3727
- sampling methods 9, 290, 300, 302, 708, 1113, 1116, 1132, 1272, 1380, 1452, 1453, 1584, 1843, 2210, 2305, 2381, 2387, 2464, 2477-2479, 2482, 2603, 2631, 2632, 2638, 2644, 2648, 2652, 2653, 2662, 2674, 2678, 2679, 2937, 2945, 3037, 3394, 3397, 3400, 3401, 3403, 3406, 3409, 3410, 3414, 3418, 3568, 3726, 3727, 3773, 3802, 3990, 3992, 4021, 4038, 4044, 4046, 4089, 4103, 4178, 4184, 4215, 4217, 4218, 4241
- sampling units 708, 1380, 2648, 3147, 3401, 3414
- sampling universe 1583-1585, 2648
- sap rots 245, 247, 249, 411, 3620
- saplings 275, 447, 1701
- Saratoga spittlebug 130, 336-338, 1508
- Sarcophagidae 3375
- Saskatchewan 203, 510, 511, 543, 721, 1201, 1436, 1695, 1696, 1813-1816, 2206, 2358, 2562, 2563, 2668, 2669, 2851, 2900, 2953, 3101, 3141, 3142, 3432, 3613, 3831, 3860
- satellite imagery 1592, 2230, 2582
- satin moth 2374
- sawflies 450, 1891, 2991
- sawyer beetles 243, 249, 1755
- scanning electron microscopy 1145, 1291, 2529, 4062
- scenic quality 372, 607, 927, 4250
- Scotch pine 1506, 2955
- SD 8530 605
- SD 9077 3106

- seasonal development 818, 3213, 3389, 3505, 3506
- seed germination 4273, 4274
- seed insects 129, 294, 1020, 1021, 1029-1031, 1345, 1631, 1649, 3007, 3198, 3199, 3346, 3347, 3349
- seed orchards 3199, 4054
- seed production 215, 294, 1028-1030, 1277, 1346, 1401, 1451, 2056, 2561, 2769, 2930, 2945, 2999, 3308, 3347-3349, 3628, 3898
- seed yields 1557, 3007, 3016, 3346, 3623, 3627
- seedling survival 4273, 4274
- seedlings 447, 697, 1424, 1425, 1451-1454, 1701, 2057, 2945, 2980, 3337, 4279
- seeds 447, 1020, 1021, 1027, 1028, 1031, 1285, 1425, 1451, 1701, 2656, 2930, 2945, 3028, 3627, 3830, 3951
- selection system 278, 1502, 1731, 4142, 4145
- sensory receptors 23, 2528, 2529, 3553, 3554
- septicemia 3469, 3472
- sequential sampling 569, 815, 1272, 2387, 2630, 3021, 3402, 3689, 4038
- serology 1710, 1974, 2126, 2127
- setae 2376, 3107, 3778
- sex determination 3509, 3585, 3938
- sex ratios 663, 1399, 1476, 1602, 1828, 1829, 2069, 2184, 2187, 2383, 2384, 2459, 2613, 2645, 2679
- sexual differences 1616, 2523, 2809, 3078, 3281, 3283, 3366, 3395, 3509, 3510, 3764, 3765, 3767, 3833, 4004
- sexual dimorphism 1829, 1848, 2037, 2067, 2376, 2459, 2809, 3509, 3580-3582, 3585
- shelterbelts 1982, 3591, 3684
- shoestring root rot 921, 2154, 3965
- shoot growth 289, 306, 635, 751, 1174-1177, 2031, 2662, 4081, 4082, 4090
- shoots 273, 1675, 2027, 2381, 2397, 2457, 2458, 2478, 2662, 2946, 3021, 3294, 3401, 3656, 3726
- shore pine 1219
- shrews 1901, 2639
- shrubs 285, 1424, 1454, 2945
- silk 272, 275, 1469, 3107, 3363, 3833, 4131
- silkworm 2428
- silver fir 2956, 3307
- silver fir shoot tortricid 914, 1398, 1885, 2956
- silvics 1595, 3290
- silviculture 26, 28, 30, 99, 112, 120, 122, 186, 189, 191, 194, 201, 209, 210, 246, 252, 256, 257, 262, 267, 295, 330, 332, 335, 357, 358, 398, 400, 411, 420, 440, 456, 472-475, 477-480, 489, 492, 502, 506, 524, 621, 679, 701, 703, 705, 737, 760, 768, 838, 877-884, 888, 894, 921, 970, 971, 973, 995, 1049, 1105, 1106, 1108, 1115, 1117, 1196, 1198, 1228, 1229, 1257, 1259, 1270, 1271, 1274, 1276, 1277, 1279, 1284, 1337, 1361, 1366, 1367, 1388-1394, 1401, 1455, 1475, 1490, 1498-1500, 1502-1504, 1506, 1508, 1568, 1596, 1623, 1625, 1648, 1676, 1707, 1721, 1756, 1803, 1851, 1879, 1882, 1912, 1978, 2039, 2055, 2056, 2074, 2097, 2100, 2116, 2152, 2156, 2159, 2167, 2183, 2252, 2265, 2296, 2337, 2345, 2377, 2389, 2409, 2462, 2497, 2520, 2548, 2549, 2554, 2650, 2652, 2661, 2663, 2672, 2684, 2689, 2724, 2761, 2765, 2776,

- 2831, 2832, 2859, 2860, 2905, 2928, 2939,
2940, 2951, 2964, 3105, 3144, 3146, 3156,
3157, 3163, 3166, 3192, 3195, 3205, 3271,
3290, 3291, 3295, 3296, 3323, 3326, 3327,
3412, 3419, 3643, 3645, 3657, 3662, 3663,
3666, 3669, 3672, 3675, 3694, 3695, 3793,
3797, 3857, 3859, 3886, 3897, 3898, 3915,
3924, 3948, 3951, 3958, 3962, 4080, 4091,
4104, 4106, 4141-4144, 4159, 4165, 4225,
4249, 4282, 4283
- simulation models 364, 777, 898, 1322, 1323,
1335, 2219, 2759, 2891, 3178, 3179, 3326,
3328, 3575-3577, 4021, 4050, 4053, 4179
- SIR 8514 2115
- site classification 1698, 3380, 4243
- site quality 265, 451, 1270, 1434, 1909, 3101,
3365
- slash 917, 3667
- smaller European elm bark beetle 558, 935,
1644
- social impacts 927, 4146
- sodium fluoraluminate 171
- sodium hydroxide washing 2475, 2477, 2482,
3802, 3805
- soil microorganisms 483, 504, 2712, 3209
- soil residues 1063, 1863, 2057, 3096, 3209, 4305,
4306
- soils 258, 548, 589, 592, 738, 882, 917, 1043,
1054, 1064, 1115, 1395, 1435, 1657, 1697,
1698, 1904, 1914, 1972, 2057, 2433, 2505,
2710, 2712, 2763, 2814, 2980, 3146, 3209,
3305, 3643, 3886, 3915, 3965, 3982, 3994,
4275, 4304-4306, 4308
- solar radiation 1535, 3226, 3372, 4123-4126,
4129, 4136, 4188, 4213, 4221
- South Dakota 130, 766, 770, 1026, 1085, 1480,
3604, 3733, 3838, 3839, 4147, 4296
- southern pine beetle 194, 768, 921, 1644, 2041
- southwestern pine beetle 3534
- spatial patterning 2131
- species composition 827, 1270, 1624, 1628, 1642,
1650, 1658, 2635, 2924, 3047
- species diversity 1817, 1818, 1853, 2399, 2961,
3990
- sperm 3067, 3081, 3082, 3084
- spermatogenesis 3080, 3081
- spermatophores 2802, 2806, 2808, 2813
- spiders 42, 52, 1276, 1351, 1409, 1410, 1440,
1655, 1790, 1791, 1852, 1859, 2071, 2126,
2127, 2197, 2457, 2489, 2491, 2639, 2718,
3047, 3092, 3318, 3405, 3852, 3990, 3992, 4251
- spiny elm caterpillar 3048
- spores 1260, 2593, 2596, 2599, 2603, 2618, 2621,
3449, 3470, 3485, 3490, 3764, 3766, 3769,
3972, 4191, 4192, 4202, 4207, 4213, 4290
- spray application equipment 148, 150, 171, 193,
233, 237, 238, 241, 324, 326, 327, 420, 505,
518, 523, 528, 553, 556, 558, 568, 591, 605,
624, 684, 725, 733, 734, 736, 741, 764, 905,
906, 909, 913, 965, 981, 986, 987, 992, 1031,
1037, 1042, 1051, 1146-1149, 1156, 1183,
1186, 1187, 1216, 1240, 1303, 1327, 1341,
1439, 1687, 1690-1692, 1761, 1808, 1811,
1812, 1878, 1939, 1995, 2074, 2274, 2345,
2476, 2492, 2543, 2570, 2612, 2615, 2625,
2685, 2705, 2766, 2767, 2775, 2845, 2847,
2854, 2988-2990, 3196, 3315, 3448, 3452,
3461, 3464, 3468, 3471, 3487, 3488, 3495,
3499, 3500, 3513, 3525, 3540, 3610, 3626,
3627, 3631, 3690, 3701, 3774, 3801, 3862,
3891, 3930, 3954, 4068, 4097, 4109, 4153,
4187, 4302, 4318

- spray application rates 157, 417, 586, 1148, 1197, 1662, 1938, 2181, 2289, 2347, 2505, 2570, 2603, 2605, 2607, 2609, 2705, 2814, 2961, 2982, 3110, 3131, 3486, 3487, 3609, 3610, 3681, 3742, 3749, 3827, 4074, 4084, 4153, 4306
- spray application technology 153, 226, 229, 874, 981, 1183, 1891, 2904, 2942, 2952, 2982, 2986, 3345, 3986, 3991, 4178, 4291, 4303
- spray applications 629, 965, 1011, 1012, 1059, 1812, 2274, 2594, 2766, 3610, 3681, 3807, 4037, 4084, 4153
- spray deposit assessment 151, 153, 158, 214, 232, 241, 980, 1182, 1264, 1543, 1811, 2272, 2596, 2603, 2616, 2621, 2937, 2981, 3451, 3487, 3488, 3525, 3912, 3939, 4000, 4295
- spray deposits 157, 226, 325, 553, 651, 757, 874, 968, 999, 1261, 1304, 1305, 1413, 1690-1692, 1726, 1728, 1730, 1812, 2081, 2269, 2271, 2272, 2295, 2505, 2593, 2596, 2597, 2599, 2603, 2609, 2613, 2621, 2705, 2746, 2937, 3107, 3319, 3486-3488, 3991, 4000, 4037, 4177, 4291, 4302
- spray drift 228, 233, 239, 727, 874-876, 1099, 1130, 1173, 1183, 1484, 2074, 2250, 2705, 3095, 3549, 3573, 3610, 3701, 3991, 4000, 4081, 4084, 4260, 4291, 4302, 4307
- spray droplet size 154, 158, 211, 214, 227, 233, 235, 240, 241, 605, 1088, 1099, 1182, 1690-1694, 2269, 2285, 2363, 2505, 2603, 2621, 2672, 2774, 2852, 2904, 2982, 2988, 3107, 3490, 3610, 3749, 3862, 4037, 4291
- spray formulations 622, 623, 684, 723, 1662, 1728, 1730, 1812, 1967, 2078, 2081, 2151, 2269, 2274, 2349, 2474, 2526, 2598, 2599, 2610, 2611, 2625, 2731, 2732, 2746, 2942, 2980, 2991, 3120, 3299, 3321, 3461, 3471, 3472, 3476, 3477, 3484-3487, 3489, 3568, 3610, 3652, 3749, 3887, 4158, 4207
- spray histories 1172, 2177, 2184, 2186, 3990, 4109, 4306
- spray test chambers 3319
- spray timing 212, 213, 289, 292, 306, 394, 400, 409, 412, 450, 455, 457, 458, 469, 578, 594, 635, 731-736, 983, 1039, 1059, 1062, 1088, 1118, 1147, 1341, 1413, 1576, 1726, 1770, 1801, 1812, 1934, 2173, 2255, 2470, 2476, 2508, 2543, 2570, 2593, 2705, 2743, 2753, 2989, 3131, 3368, 3468, 3495, 3610, 3631, 3640, 3660, 3856, 3862, 3923, 3991, 3993, 4037, 4069, 4080-4082, 4101, 4153, 4207, 4208, 4260, 4302, 4306
- spring cankerworm 1581
- spruce 244, 285, 494, 501, 514, 740, 888, 1017, 1313, 1389, 2060, 2091, 2145, 2218, 2534, 2771, 2784, 3176, 3290, 3324, 3436, 3685, 3798, 4023, 4164
- spruce beetle 129, 524, 673, 921, 1121, 1554, 1817, 2035, 2374, 2877, 3534, 3921, 3922
- spruce budworm 1, 8-12, 14-29, 36-41, 43-46, 48-50, 58-64, 69, 71-74, 82-85, 88-95, 97-101, 103-110, 112-115, 117, 118, 120-122, 124, 125, 127, 128, 131-143, 145-147, 150-170, 172, 173, 176-178, 181-189, 191-194, 196-214, 216-224, 229, 232, 233, 238, 242-263, 265-267, 269, 272-278, 280, 281, 285, 288-310, 317-321, 323, 340-342, 346-349, 351-356, 358, 359, 361-368, 372-378, 380-385, 387, 391, 393, 394, 396-401, 403-469, 471, 473-481, 485, 486, 488-490, 503-507, 509, 512-516, 522, 525-527, 529-546, 548-550, 552-561, 563-569, 576, 578, 579, 581, 582, 584-596, 598-600, 603, 612, 618, 619, 621-623, 625, 627-629, 634-646, 651, 652, 667-671, 673-679, 681, 682, 684-696, 698, 709, 713, 716, 719-741, 743, 748-750, 752-754, 757, 758, 761-763, 768, 776-791, 793-801, 816, 819-823, 827, 829-837, 839-843, 845, 846, 848, 850, 856, 858-867, 869-872, 875-889, 892, 894-902, 904-909, 911-921, 928, 935-943, 945-963, 965, 968-980, 982-989, 992, 993, 997, 1007, 1009-1017, 1023, 1024, 1032-1063, 1065, 1067-1072, 1078-1084, 1087, 1097-1107, 1112-1124, 1126-1128, 1130, 1132-1134, 1136-1138, 1140, 1142-1154, 1156, 1158-1181, 1184-1192, 1195-1204, 1206,

1207, 1209-1214, 1216-1218, 1220-1222, 1257-1268, 1288, 1289, 1291, 1292, 1295, 1299-1306, 1308, 1312-1314, 1316, 1317, 1319-1326, 1330, 1331, 1333-1347, 1352-1359, 1361-1383, 1385, 1388-1399, 1402, 1404-1407, 1409-1411, 1416, 1418-1425, 1427, 1429, 1430, 1432-1440, 1445-1462, 1464-1466, 1469-1471, 1477, 1478, 1481-1491, 1493-1495, 1499-1501, 1503-1505, 1507-1522, 1526-1540, 1542-1545, 1547-1550, 1552, 1554-1558, 1560, 1562, 1564-1570, 1572-1581, 1594-1612, 1614-1616, 1618-1620, 1623-1637, 1640, 1642-1646, 1648, 1650-1653, 1657-1663, 1665-1671, 1675, 1676, 1679-1690, 1694-1699, 1708, 1712-1720, 1723, 1725-1731, 1733-1736, 1738-1752, 1754, 1756-1774, 1776-1779, 1781-1788, 1790-1809, 1811-1819, 1824, 1826-1834, 1836, 1840-1860, 1876-1886, 1888-1890, 1894, 1896-1902, 1904, 1908-1912, 1915-1919, 1922-1953, 1955-1959, 1966, 1967, 1970-1974, 1976-1980, 1984, 1987-1990, 2000, 2001, 2006, 2007, 2009-2013, 2017, 2019-2026, 2035-2039, 2041, 2048-2054, 2056, 2058-2062, 2064-2066, 2070-2074, 2078-2083, 2088-2094, 2104, 2106, 2120-2146, 2148, 2149, 2155-2158, 2160-2198, 2200-2204, 2206-2225, 2227-2234, 2236-2268, 2270, 2272, 2275-2278, 2280, 2297, 2298, 2300, 2302-2306, 2308-2314, 2316, 2318, 2320-2322, 2327-2337, 2345-2352, 2358, 2359, 2361, 2371-2377, 2379, 2389, 2394, 2396-2413, 2415-2431, 2433, 2443-2491, 2493, 2494, 2497, 2504-2506, 2509, 2510, 2512-2520, 2523, 2526-2534, 2536-2541, 2543-2569, 2571-2584, 2590-2595, 2597-2600, 2602, 2604-2611, 2613, 2614, 2616, 2617, 2619-2632, 2634-2652, 2654-2658, 2660, 2661, 2663-2684, 2689-2695, 2698-2700, 2703-2710, 2712-2721, 2723-2730, 2732-2742, 2744-2748, 2753-2758, 2760, 2761, 2765-2768, 2770-2776, 2781, 2782, 2785-2795, 2797-2818, 2820-2832, 2848-2878, 2880-2885, 2887-2889, 2892, 2895, 2896, 2899-2902, 2905-2911, 2915, 2917-2921, 2923-2930, 2933, 2936-2939, 2941, 2943-2949, 2951, 2956-2960, 2962, 2972-2992, 2994, 2996-3002, 3004-3006, 3008-3012, 3018-3027, 3029-3037, 3043-3049, 3052-3062, 3064-3088, 3090-3093, 3095-3097, 3103-3105, 3113, 3122, 3141-3144, 3146-3155, 3164, 3165, 3167, 3169-3172, 3174-3177, 3181, 3183-3185, 3187, 3188, 3193-3197, 3199, 3201, 3204, 3206-3212,

3214-3237, 3239-3248, 3250-3263, 3265, 3268, 3271-3273, 3280, 3285-3289, 3298, 3300-3305, 3308-3310, 3317-3322, 3324-3330, 3334-3341, 3345, 3350-3353, 3357, 3361, 3362, 3367, 3374, 3375, 3377, 3379-3384, 3386, 3390, 3393, 3394, 3396-3417, 3419-3421, 3423-3441, 3443-3448, 3450-3452, 3454-3457, 3460-3465, 3467-3469, 3471-3478, 3480-3491, 3493-3500, 3505-3508, 3511-3519, 3522, 3523, 3526-3532, 3535-3538, 3541-3544, 3546, 3549, 3552-3554, 3556, 3558-3564, 3566-3569, 3572-3584, 3591, 3594-3600, 3607-3612, 3614, 3615, 3617-3621, 3632, 3635, 3641, 3647, 3648, 3650, 3651, 3654, 3657-3669, 3671-3675, 3680, 3683, 3684, 3687-3689, 3691, 3692, 3710, 3713, 3728, 3734, 3736-3748, 3750, 3751, 3760, 3762-3768, 3770-3772, 3774-3777, 3779-3786, 3791-3798, 3800-3830, 3832, 3833, 3837, 3850-3853, 3860-3862, 3864-3866, 3868, 3876-3890, 3894, 3899, 3906-3914, 3916, 3924-3929, 3932-3939, 3941-3944, 3953, 3957-3960, 3963-3970, 3972-3993, 3995-4001, 4008, 4010, 4014, 4016, 4020, 4022-4027, 4035-4039, 4041-4052, 4054, 4056-4062, 4064-4090, 4092-4110, 4112-4135, 4137-4145, 4147, 4157, 4159, 4162-4165, 4171-4173, 4178, 4185-4204, 4206, 4208-4212, 4214, 4216-4221, 4223-4225, 4228-4232, 4235-4250, 4253, 4256-4260, 4266, 4267, 4273-4278, 4288-4291, 4295, 4302-4305, 4308, 4310, 4312, 4313, 4315-4318

spruce cone maggot 524

spruce coneworm 1559, 1762, 1959, 2104, 2206, 2282, 2402, 3007, 3541, 3543

spruce leaf rust 2056

spruce mealybug 3534

spruce needleminer 2056

spruce seed moth 2374

spruce seedworm 524

spruce spider mite 1273, 3048, 3868

spruce tip moth 2282

- staining techniques 1170, 1839, 2073
- stalactiform rust 2931
- staminate flower temperature 4125, 4126
- staminate flowers 192, 209, 276, 367, 368, 412,
438, 448, 466, 772, 896, 953, 1384, 1426, 1500,
1506, 1530, 1535, 1538, 1672-1675, 1704,
1828, 1829, 1875, 2027, 2030, 2067-2069,
2481, 2675, 2677, 2862, 3364, 3571, 3875,
4125, 4126
- stand age 196, 199, 209, 265, 267, 273, 275, 447,
450, 1424, 1437, 1451, 1455, 1505, 1537, 1628,
1642, 1704, 2318, 2409, 2457, 2635, 2636,
2675-2677, 3101, 3662, 3663, 3998
- stand composition 196, 199, 215, 257, 262, 266,
267, 274, 285, 441, 442, 447, 551, 552, 671,
701, 838, 881, 882, 888, 1270, 1286, 1424,
1425, 1437, 1450, 1452, 1454, 1499, 1505,
1531, 1539, 1573-1575, 1596, 1628, 1642,
1650, 1658, 1661, 1697, 1731, 1734, 2000,
2050, 2213, 2222, 2406, 2433, 2457, 2481,
2635, 2658, 2676, 2677, 2798, 2831, 2941,
2947, 3398, 3776, 3792, 3853, 3859, 3996,
4134, 4181
- stand conditions 41, 52, 54-59, 63-66, 78, 117,
164-166, 168, 189, 190, 196, 199, 225, 258-260,
265, 291, 308, 331, 333, 335, 339, 432, 435,
440, 442, 447, 480, 493, 494, 501, 572, 671,
750, 755, 756, 780, 782, 783, 786, 802, 803,
805, 806, 810, 811, 813, 814, 817, 851-854,
856, 881, 954, 1001-1006, 1020, 1021, 1028,
1075, 1085, 1092-1094, 1108, 1109, 1215,
1223-1225, 1228-1233, 1235-1239, 1244-1249,
1251-1254, 1270, 1273, 1309, 1328, 1361,
1375, 1412, 1414, 1425, 1434, 1443, 1450,
1452, 1454, 1467, 1490, 1500, 1505, 1522,
1531, 1537, 1539, 1541, 1558, 1596, 1619,
1624, 1626, 1628, 1658, 1661, 1697, 1704,
1732, 1734, 1761, 1821, 1865-1872, 1908-1910,
1916, 1931, 1936, 1963, 1991-1994, 2030,
2042, 2047, 2057, 2076, 2095, 2103, 2109,
2110, 2117, 2118, 2137-2140, 2156, 2222,
2237, 2240, 2304, 2307, 2342, 2365, 2369,
2373, 2408, 2409, 2434, 2439, 2457, 2461,
2465, 2476, 2483, 2534, 2538, 2558, 2565,
2581, 2584-2588, 2635, 2641, 2652, 2654,
2658, 2677, 2724, 2749-2752, 2763, 2798,
2914, 2964, 3031, 3101, 3105, 3145, 3178,
3260, 3354, 3372, 3392, 3436, 3530, 3547,
3548, 3586, 3594, 3599, 3610, 3656, 3666,
3668, 3670, 3706-3708, 3714-3716, 3718, 3720,
3731, 3733, 3770, 3783, 3791-3793, 3795,
3798, 3809, 3814, 3815, 3834, 3867, 3889,
3893, 3902, 3921, 3961, 3969, 3998, 4011,
4026, 4028, 4029, 4039, 4074, 4111, 4134,
4166, 4167, 4181, 4262, 4264-4267, 4283
- stand density 267, 274, 282, 333, 701, 1073,
1075, 1270, 1453, 1506, 1658, 1875, 2481,
2677, 3178, 3291, 3398, 3610, 3875, 3996,
3998, 4011, 4039
- stand dynamics 472, 1488, 3328
- stand isolation 2677, 4049
- stand management 122, 196, 199, 202, 209, 210,
267, 277, 420, 435, 450, 973, 995, 1277, 1500,
1650, 1704, 1721, 1731, 2074, 2154, 2156,
2183, 2337, 2387, 2409, 2490, 2497, 2654,
2890, 3297, 3662, 3663, 3792, 3793, 3797,
4142, 4181
- stand regeneration 122, 265, 272, 294, 401, 848,
973, 1073, 1075, 1257, 1277, 1293, 1294, 1395,
1423-1425, 1451-1454, 1628, 1701, 1721, 2048,
2057, 2689, 2890, 2945, 3028, 3297, 3372,
3662, 3667, 3996, 3998, 4165, 4273
- stand structure 1424, 1425, 1437, 1455, 1734,
2031, 2318, 2409, 2674-2677, 3178, 3372,
3594, 3656, 3792, 3853, 3859, 3998, 4098, 4184
- stand volume 2219, 2408, 3998
- starvation 450, 1038, 1174-1176, 1509, 2452,
2634, 2660, 2828, 3250, 3656, 3792, 4080,
4129, 4133
- statistics 1295, 1378, 1383, 1452, 1453, 1546,
1911, 1912, 2123, 2384, 2452, 2633, 2640,
2648, 3189, 3281, 3394, 3395, 3409, 3410,
3551, 3689, 4000, 4021, 4033, 4038, 4044,
4053, 4176, 4178, 4241

- stem analyses 33, 176, 177, 3998, 4313
- stem implants 2115, 3006, 3007, 3013-3016, 3624
- stem injections 2115, 3006, 3007, 3013, 3016, 3624
- sterility 837, 899, 1699, 2798, 2812, 3067, 3078, 3080, 3084, 3228, 3505, 3506
- sticky traps 1606, 1849, 1854, 3036, 3735
- stirofos 153, 324, 326, 327, 336
- stomach toxicity 2731, 2742
- stomach-content analyses 1431, 2324, 2532, 2567
- stream drift sampling 490, 827, 1954, 2896, 2961, 3408, 3682
- striped alder sawfly 2374
- strobili 2323, 2930
- subalpine fir 2-4, 6, 13, 30, 180, 195, 314, 343, 344, 369, 370, 494, 701, 765, 1108, 1498, 1960, 2076, 2098, 2099, 2209, 2293, 2366, 3158, 3160, 3166, 3625, 3642, 3835, 3840, 3848
- sublethal dosage 2599, 2609, 3090, 3503, 3504, 3682, 4191
- sublethal effects 40, 1268, 2280, 2894, 3090, 4191
- succession 25, 170, 256, 285, 435, 440, 450, 1173, 1450, 1697, 2053, 2420, 2999
- sugar maple 1624, 4110
- sugar pine 3122
- sugar pine tortrix 179, 190, 195, 700, 770, 1024, 1473, 1480, 1492, 1722, 1723, 1823, 1962, 1963, 2365, 2368-2370, 2851, 2914, 3602, 3632
- sulprofos 1641, 2115, 2291, 3099, 3124, 3344
- surveys 6, 54, 55, 65, 66, 183, 184, 225, 335, 403, 404, 408, 493, 771, 813, 853, 1092-1094, 1215, 1228, 1229, 1309, 1412, 1414, 1542, 1558, 1774, 1867, 1931, 1961, 2006, 2047, 2095, 2342, 2585, 2587, 2588, 3023, 3031, 3094, 3654, 3707, 3719, 3721, 3729, 3733, 3770, 3951, 3961, 3970, 4031, 4032, 4068, 4111, 4118, 4149, 4176, 4266, 4267
- survival 282, 404, 556, 558, 656, 665, 707, 712, 896, 1530, 1909, 1911, 2447, 2466, 2561, 2646, 3103, 3337, 3523, 3562, 3580, 3582, 3723, 4021, 4133
- survival rates 2184, 2384, 2645, 2677, 3790
- susceptibility 168, 172, 196, 199, 202, 209, 257, 394, 396, 400, 442, 450, 473, 488, 551, 552, 697, 700, 701, 714, 892, 921, 1075, 1270, 1286, 1337, 1345, 1437, 1450, 1455, 1495, 1505, 1518, 1554, 1642, 1650, 1673, 1674, 1721, 1732, 1859, 2074, 2150, 2197, 2293, 2318, 2457, 2488, 2677, 2724, 2832, 2936, 2984, 3121, 3318, 3565, 3742, 3792, 3969, 4144, 4184, 4222, 4236, 4245, 4249, 4281, 4282
- Swaine jack pine sawfly 676, 914, 1755, 2418
- sweet fern blister rust 2931
- synergism 605, 611, 3106, 3136, 3247, 3334
- synthetic diets 51, 340, 488, 1547-1549, 1603, 1604, 1610, 1736, 1739, 1740, 2393, 2411, 2535, 3062, 3085, 3113, 3283, 3335, 3446, 3453, 3465, 4119, 4120, 4203, 4204
- systemic toxicity 2046, 2737, 2980, 3014, 3015
- Tachinidae 290, 2328, 2805
- tactile communication 2528, 3552-3554
- tamarack 473, 729, 896, 1510, 1557, 1744, 1841, 2345, 2682, 3000
- taxonomy 8, 531, 563, 793, 818, 873, 926, 928, 1219, 1402-1408, 1605, 1608, 1611, 1613, 1650, 1705, 2206, 2207, 2315, 2316, 2377, 2494, 2688, 2762, 2846, 2886, 2932, 2933, 2935, 3003, 3167, 3238, 3375, 3506, 3586, 4009, 4018, 4019, 4223

- TDE 153
- technology transfer 28, 492, 502, 1199, 1338,
1372, 1390, 1396, 1401, 1778, 1973, 2359,
2539-2542, 2546, 3149-3155, 3570, 4243, 4247,
4248
- temephos 153
- temperature 312, 650, 1032, 1164, 1167, 1287,
1530, 1565, 1614, 1616, 1832, 1940, 2085,
2130, 2154, 2185, 2412, 2413, 2460, 2480,
2523, 3034, 3035, 3038, 3041, 3042, 3355,
3453, 3723, 3754, 3756, 3769, 3972, 4002,
4004, 4049, 4125, 4126, 4135, 4188, 4201
- Tennessee warbler 622-624, 2656
- tent caterpillars 1581
- terpenes 745-747, 3017, 4012
- testes 1207, 3080, 3081, 3333, 3585
- tetrachlorvinphos 987, 2605, 2728, 2737
- Theridiidae 1859, 2126, 2127
- thesaurus 1788
- thigmotaxis 4217, 4220
- thinning 266, 282, 705, 892, 1704, 1832, 2832,
2860, 3675, 3859, 3898, 4282
- thiodicarb 1641, 1663, 3099, 3124, 3135
- thiotepa 3084
- threelined larch sawfly 1813
- threshold levels 3234, 4053
- threshold temperature 288, 2469, 3224, 3744
- ticks 2300
- timber loss 333, 459, 1192, 1628, 1874, 2156,
2871
- tissue culture 14, 378, 3521-3523
- todo fir 1885, 3045
- topical applications 2150, 2524, 2801, 2809,
2819, 3068, 3084, 3085, 3088, 3109, 3120,
3121, 3778
- topkill 13, 269, 370, 371, 496, 765, 1309, 1412,
2002, 2066, 2585, 3159, 3298, 3617, 3621,
3697, 3942, 4039, 4176, 4184, 4261, 4270, 4271
- topography 1940, 2658, 3853
- Tortricidae 8, 2417, 2762, 2846
- toxaphene 153, 528, 542, 1096
- toxicity 67, 70, 488, 578, 915, 985, 1007, 1162,
1260, 1304, 1377, 1448, 1559, 1789, 2151,
2187, 2192, 2524-2526, 2730-2733, 2735-2744,
2819, 2984, 2986, 2991, 3072, 3083, 3109,
3110, 3114, 3120-3122, 3130, 3132, 3135,
3139, 3321, 3334, 3503, 3635, 3636, 3640,
3681, 3778, 3982, 4188, 4290
- toxicology 2043, 2044, 3072, 3106, 3991
- trap-nesting wasps 816, 1421, 1422, 1742, 1851
- tree age 964, 1701, 1951, 2154, 2337, 2890, 3020,
3021, 3853, 4144
- tree condition 2-4, 165, 180, 278, 496, 604, 785,
1134, 1352, 1711, 1946, 1962, 1968, 2112,
2186, 2187, 2191, 2192, 2197, 2232, 2337,
2509, 2675, 2719, 2789, 2792, 2835-2838,
2843, 3369, 3537, 3538, 3864, 3873, 3874,
4010, 4077, 4142, 4144
- tree damage 13, 83, 85, 96, 102, 165, 166, 169,
191, 198, 247-249, 255, 265, 269, 272, 274,
277, 278, 284, 332, 339, 346, 366, 397, 400,
420, 425, 432, 457, 458, 499, 523, 526, 540,
545, 557, 561, 562, 641, 642, 674, 679, 680,
686, 700, 709, 713, 716, 721, 735, 737, 769,
817, 878, 881, 940, 955, 956, 960, 990, 1008,
1015, 1017, 1023, 1046, 1076, 1077, 1089,

- 1103, 1115, 1134, 1190, 1256, 1259, 1279, 1281-1283, 1286, 1293, 1297, 1298, 1312, 1352, 1368, 1376, 1386, 1401, 1415, 1428, 1440, 1454, 1485, 1514, 1578, 1619, 1625, 1649, 1659, 1672, 1673, 1701, 1717, 1719, 1720, 1734, 1762, 1824, 1825, 1859, 1874, 1895, 1964, 1985, 2007, 2021, 2031, 2057, 2066, 2074, 2102, 2141-2144, 2154, 2155, 2158, 2159, 2197, 2213, 2304, 2311, 2317, 2337, 2368, 2369, 2397, 2404, 2406, 2410, 2422, 2423, 2449, 2457, 2461, 2498, 2533, 2548, 2554, 2560, 2653, 2654, 2658, 2676, 2677, 2698, 2700, 2719, 2763, 2764, 2770-2772, 2816, 2860, 2890, 2939-2942, 2998, 2999, 3020, 3021, 3163, 3174, 3176, 3180, 3182, 3271, 3292, 3294, 3351, 3389, 3406, 3419, 3441, 3472, 3530, 3588, 3589, 3599, 3608, 3617, 3621, 3646, 3649, 3656, 3657, 3663, 3666, 3668, 3673, 3684, 3698, 3699, 3702, 3711, 3726, 3727, 3791-3793, 3795, 3797, 3807, 3830, 3906, 3921, 3922, 3945, 3951, 4039, 4078, 4081, 4090, 4091, 4105, 4141, 4152, 4154, 4175, 4176, 4181, 4184, 4216, 4238, 4239
- tree deformities 114, 1277, 1282, 1283, 3294, 3617, 3621
- tree growth 33, 119, 167, 192, 261, 265, 266, 372, 373, 471, 514-516, 697, 751, 761, 821, 881, 893, 964, 1277, 1294, 1297, 1434, 1435, 1451, 2026, 2049, 2052, 2056, 2194, 2209, 2213, 2217, 2248, 2405, 2407, 2635, 2649, 2682, 2722, 2907, 2910, 3178, 3208, 3294, 3297, 3325, 3353, 3355, 3356, 3362, 3526-3528, 3530, 3755, 3792, 3915, 3997, 3998, 4011, 4024, 4134, 4175, 4250, 4279
- tree improvement 697, 729, 730, 1345, 1563, 1707, 2321, 2354-2357, 3650, 4012, 4279
- tree mortality 32, 34, 41, 54, 55, 65, 85, 102, 117, 132, 165, 170, 202, 221, 245, 247-249, 255, 260, 265, 266, 269, 274, 277, 309, 317, 318, 320, 322, 325, 329-331, 333, 339, 343, 370, 372, 400, 401, 405, 410, 411, 417, 425, 429, 431, 432, 450, 451, 459, 468, 491, 493, 499, 501, 510, 514-516, 523, 534, 545, 673, 674, 681, 686, 691, 692, 719, 724, 737, 756, 765, 780, 782, 783, 786, 803, 806, 839, 840, 853, 881, 960, 963, 972, 1013, 1015, 1016, 1073, 1075-1077, 1093, 1094, 1109, 1123, 1133, 1134, 1192, 1247, 1257, 1288, 1309, 1312, 1313, 1342, 1361, 1364, 1375, 1387, 1412, 1438, 1439, 1450, 1454, 1455, 1481, 1486, 1499, 1509, 1531, 1541, 1550, 1558, 1578, 1596, 1617-1619, 1626-1628, 1648, 1701, 1712, 1732, 1743, 1745, 1759, 1761, 1762, 1801, 1821, 1866, 1882, 1886, 1899, 1929, 1964, 1965, 1991, 1993, 1994, 2000, 2006, 2026, 2032, 2033, 2042, 2047, 2049, 2050, 2052, 2057, 2066, 2102, 2117, 2118, 2137-2144, 2154, 2171, 2181, 2197, 2208-2210, 2212, 2213, 2217, 2218, 2222, 2304, 2310, 2319, 2334, 2343, 2359, 2373, 2404, 2406, 2414, 2420, 2422, 2423, 2439, 2449, 2457, 2461, 2468, 2497, 2499, 2514, 2533, 2534, 2549, 2558, 2559, 2561, 2574-2580, 2585, 2587, 2588, 2635, 2656, 2672, 2690, 2695, 2699, 2701, 2706, 2708, 2753, 2757, 2770, 2789-2792, 2798, 2871, 2877, 2878, 2890, 2925, 2927, 2929, 2944-2946, 2966, 2994, 2996, 2998, 2999, 3004, 3031, 3145, 3159, 3163, 3174, 3204, 3208, 3273, 3298, 3322, 3324, 3351, 3569, 3587-3589, 3599, 3608, 3617, 3620, 3647, 3656, 3662, 3667, 3671, 3673, 3674, 3697, 3707, 3709, 3733, 3748, 3770, 3791, 3793-3795, 3804, 3808-3813, 3853, 3863, 3888, 3889, 3922, 3924, 3934, 3941, 3942, 3948, 3951, 3961, 3967, 4024, 4039, 4068, 4077, 4080, 4081, 4098, 4105, 4107, 4108, 4139, 4152, 4153, 4165-4167, 4184, 4237, 4243, 4244, 4249, 4250, 4262, 4266, 4267, 4271, 4279, 4293
- tree phenology 306, 1167, 1174-1177, 1531, 1535, 2662, 3792
- tree physiology 774, 1139-1141, 2930, 3093
- tree species 311
- tree vigor 745, 746, 1114, 1704, 2154, 2635, 2890, 3000, 3376, 3406, 3748, 4012, 4176
- trichlorfon 104, 123, 152, 153, 156, 234-236, 238, 336, 337, 399, 684, 685, 992, 1017-1019, 1126,

- 1127, 1182, 1275, 1325, 1327, 1329, 1363, 1560, 1594, 1638, 1644, 1745, 1937, 1944, 2022, 2246, 2251, 2252, 2280, 2285, 2333, 2769, 2883, 2894, 2959, 2962, 3096, 3132, 3191, 3280, 3345, 3405, 3419, 3513, 3573, 3813-3815, 3824, 3825, 3842, 3925, 3926, 3980, 3988, 4257, 4314
- Trichoptera 870, 1151, 1621, 3821
- true fir 363, 632, 717, 756, 1412, 1419, 1541, 1963-1965, 2042, 2077, 2321, 2357, 2434, 2439, 2687, 2696, 2838, 3159, 3290, 3587, 3588, 3622, 3644, 3678, 3685, 3722, 4002, 4005, 4166, 4167
- two-year-cycle budworm 54, 55, 58, 59, 64, 143, 377, 379, 395, 561, 689, 825, 826, 853, 856, 1091-1095, 1215, 1307-1311, 1522, 1584, 1585, 1605, 1718, 1732, 1788, 1814, 1816, 1844-1846, 1856, 1980, 2001, 2003, 2023-2025, 2270, 2300, 2317, 2319, 2377, 2562, 2584, 2586, 2589, 2851, 2900, 2901, 3141, 3142, 3248, 3249, 3354-3358, 3364-3366, 3370, 3584, 3596-3598, 3632, 3688, 3785, 3829, 3961, 4253, 4255, 4256, 4263, 4266, 4267
- UC 62644 2231, 3066, 3123
- uglynest caterpillar 2062, 2064, 4206
- ultraviolet radiation 5, 1838, 4124, 4188, 4213
- understory 1450, 1451
- United States 699, 763, 768, 1416, 1644, 1706, 1977, 3784, 3785
- unknown mortality 2383, 2384, 2460, 2714
- Utah 180, 1029, 1962-1965, 1968, 1969, 2367, 2687, 2780, 2781, 2836-2838, 2843, 3200, 3202, 3203, 3534, 3867, 3873, 3874, 3947, 4030, 4032
- vegetative buds 276, 772, 4126
- Vermont 1, 26-28, 45, 46, 76, 77, 398, 471, 556, 558, 652, 969, 1569, 1778, 1899, 1900, 2079, 2155-2157, 2254, 2359, 2708, 2867, 3376, 3379-3381, 3399, 3432, 3691, 3692, 4014, 4016, 4035, 4036, 4041, 4043
- viral development 387, 389-391
- viral morphology 144, 360, 362, 385, 386, 389, 391, 392, 395, 396
- viral transmission 395, 2600, 2613
- Virginia pine sawfly 914
- viruses 69, 71, 143, 144, 156, 360-362, 384-387, 389-396, 487, 575, 600, 610, 613-617, 636-638, 640, 673, 737, 837, 899, 900, 903, 908, 911, 912, 1041, 1184, 1257, 1333, 1493, 1494, 1699, 1770, 1882, 1887, 1891, 1898, 1974, 2016, 2017, 2120, 2270, 2300, 2489, 2515, 2598, 2600, 2613, 2621, 2624, 2625, 2713, 2714, 2745, 2798, 3064, 3085, 3295, 3306, 3443, 3446, 3458, 3459, 3500, 3549, 3558, 3560, 3564, 3565, 3749, 4064, 4121, 4196, 4317
- vitamins 1736, 2226
- volcanic ash 3735
- volume losses 31, 719, 724, 765, 1550, 1628, 2219, 2694, 2699, 2757, 2907, 2929, 3004, 3942, 4139, 4244, 4313
- vulnerability 168, 274, 320, 432, 442, 451, 453, 473, 480, 692, 701, 954, 1073, 1270, 1286, 1337, 1596, 1627, 2212, 2215, 2216, 2218, 2334, 2404, 2408, 2461, 2628, 2635, 2654, 2661, 3002, 3144, 4181, 4236, 4245, 4249, 4282
- waferboard 219, 244, 1449, 1781
- walkingstick 336, 337
- Washington 13, 91, 111, 123, 126, 211, 314, 315, 518, 601-604, 620, 654, 656-658, 660, 661, 664, 706, 714, 742, 744, 766, 770, 847, 866-868, 893, 932, 1085, 1096, 1157, 1288, 1400, 1403, 1414, 1442, 1443, 1492, 1541, 1617, 1722, 1723, 1843, 1904, 1906, 1913, 1961, 2095, 2435, 2436, 2438, 2685, 2722, 2749-2752, 2773, 2893, 2898, 3111, 3140, 3145, 3547, 3548, 3550, 3551, 3590, 3733, 3749, 3787-3790, 3799, 3855, 3863, 3867, 3894, 3900, 3921, 3922, 4015, 4055, 4056, 4147-4149, 4152, 4153, 4177, 4178

- water 1115, 1337, 1972, 2505, 2710, 2937, 3096,
3109, 3372, 3994, 4310
- water quality 1152, 1213, 1463, 1725, 1727, 2793,
2913
- wattle bagworm 914
- weather 63, 87, 102, 111, 120, 149, 169, 211, 238,
239, 256, 267, 282, 296, 304, 315, 326, 343,
367, 406, 412, 423, 425, 435, 439, 443, 445,
456-458, 566, 573, 725, 726, 731, 735, 783,
786, 859, 863, 875, 876, 896, 914, 941, 964,
980, 1006, 1033, 1038, 1042, 1051, 1062, 1070,
1089, 1101, 1104, 1115, 1122, 1146, 1148,
1179, 1181, 1259, 1279, 1281, 1286, 1305,
1314, 1349, 1351, 1399, 1409, 1529, 1530,
1532, 1535-1539, 1556, 1571, 1668-1670, 1756,
1761, 1813, 1815, 1816, 1904, 1948, 1983,
2010, 2042, 2055, 2107, 2114, 2130, 2154,
2175, 2176, 2185, 2189, 2191, 2193, 2194,
2251, 2259, 2262, 2264, 2317, 2344, 2376,
2384, 2395, 2399, 2410, 2414, 2417, 2439,
2449, 2453, 2460, 2463, 2480, 2483, 2492,
2501, 2508, 2516, 2592, 2593, 2599, 2612,
2618, 2631, 2641, 2643, 2687, 2705, 2714,
2716, 2742, 2744, 2753, 2760, 2794, 2798,
2840, 2854, 2866, 2917, 2920, 2939, 2946,
2988, 2997, 3175, 3185, 3220, 3235, 3254,
3263, 3307, 3314, 3316, 3319, 3342, 3354,
3358, 3363, 3370, 3372, 3395, 3421, 3438,
3469, 3507, 3573, 3610, 3658, 3670, 3690,
3695, 3705, 3712, 3738, 3753, 3758, 3808-
3812, 3845, 3855, 3856, 3891, 3906, 3924,
3972, 4026, 4039, 4049, 4051, 4066, 4081,
4122, 4124, 4126, 4129, 4130, 4132-4135,
4156, 4249, 4265, 4294, 4317
- weevils 249, 400
- West Virginia 45, 46
- western blackheaded budworm 524, 934, 2282,
3357, 3922
- Western Canada 2931
- western false hemlock looper 524, 3357
- western gall rust 524, 2931
- western hemlock 3357, 3642, 3840
- western hemlock looper 524
- western juniper 934
- western larch 314, 370, 501, 655, 702, 1028-1030,
1157, 1498, 2209, 3291-3293, 3296, 3347,
3349, 3357, 3835, 3840, 3848
- Western North America 316, 608, 609, 677, 678,
680, 700, 716, 717, 930, 934, 1023, 1279, 1286,
1415, 1417, 1546, 2023-2025, 2371, 3294,
3295, 3605, 3857, 3869, 3899, 4299
- western pine beetle 805, 921, 1554, 1644, 1979,
2893
- western pine shoot borer 934, 936, 2035, 3094
- western spruce budworm 2-7, 13, 30-35, 54-57,
63, 65-68, 75-81, 86, 87, 116, 119, 123, 126,
129, 130, 153, 171, 175, 179, 195, 225, 227,
229, 230, 234-237, 239, 241, 242, 286, 311-316,
343-345, 369-372, 402, 470, 483, 484, 487,
491-502, 517, 518, 521, 523, 524, 528, 547,
561, 562, 570-574, 577, 601, 602, 604, 605,
607-609, 620, 630-633, 653-666, 677, 680, 689,
701-708, 710-715, 717, 718, 742, 744-747, 755,
756, 759, 760, 763-767, 770, 771, 802-815, 817,
828-833, 836, 844, 847, 849, 851-855, 857, 868,
889, 890, 893, 899, 900, 907, 910, 914, 920,
922-925, 930, 932-936, 966, 967, 996, 998-
1006, 1008, 1018-1022, 1025-1031, 1085, 1086,
1088, 1090, 1095, 1096, 1108-1111, 1157,
1182, 1193, 1215, 1218, 1219, 1223-1227,
1229-1257, 1270-1287, 1293, 1294, 1298, 1307-
1311, 1318, 1327-1329, 1332, 1360, 1381,
1386, 1387, 1400, 1401, 1412-1415, 1417,
1441-1443, 1446, 1467, 1468, 1472, 1473,
1475, 1479, 1480, 1492, 1496-1498, 1518,
1521, 1541, 1545, 1546, 1551, 1554, 1559-
1561, 1563, 1571, 1582, 1583, 1586, 1588-
1591, 1593, 1605, 1607, 1608, 1612, 1617,
1621, 1638-1641, 1644, 1664, 1677, 1678,
1682, 1691-1693, 1699, 1700, 1707, 1709,
1711, 1718, 1722, 1724, 1753, 1788, 1789,
1819, 1820, 1822, 1823, 1831, 1836, 1842-

- 1846, 1856, 1861, 1862, 1864-1874, 1892, 1893, 1895, 1898, 1903-1907, 1913, 1914, 1921, 1960-1965, 1969, 1973, 1977, 1980, 1982-1986, 1991-1999, 2001-2005, 2013, 2018, 2023-2026, 2040, 2042-2044, 2046, 2047, 2055, 2075-2077, 2082, 2084-2087, 2095-2103, 2105, 2107-2119, 2147-2152, 2209, 2270, 2273, 2279, 2281-2296, 2299-2301, 2319, 2321, 2339-2344, 2351, 2353-2357, 2360, 2362-2364, 2366, 2367, 2370, 2377, 2378, 2380-2393, 2414, 2428, 2432, 2434-2441, 2492, 2511, 2521, 2522, 2526, 2535, 2542, 2585-2587, 2601, 2622, 2685-2687, 2696, 2697, 2722, 2749-2752, 2777-2780, 2783, 2784, 2819, 2834-2843, 2846, 2847, 2893, 2898, 2916, 2922, 2940, 2963-2971, 2988, 2993, 2995, 3006, 3007, 3013-3017, 3038-3042, 3094, 3097-3100, 3106, 3107, 3109-3140, 3145, 3156-3164, 3166, 3180, 3182, 3198, 3200, 3202, 3203, 3205, 3248, 3266, 3267, 3269, 3270, 3274-3279, 3290-3296, 3299, 3311-3316, 3323, 3332, 3342, 3344, 3346-3349, 3357, 3359-3361, 3368, 3369, 3371, 3373, 3378, 3383, 3387, 3389, 3391, 3392, 3500, 3503, 3504, 3524, 3525, 3534, 3539, 3540, 3547, 3548, 3550, 3551, 3555-3557, 3570, 3584, 3587-3590, 3592, 3593, 3597, 3598, 3601, 3605, 3606, 3622-3645, 3676-3679, 3685, 3686, 3688, 3690, 3693-3709, 3711, 3712, 3714-3726, 3729-3733, 3735, 3749, 3752-3759, 3773, 3778, 3783-3785, 3787-3790, 3799, 3834-3836, 3838, 3840-3849, 3854-3859, 3863, 3867, 3869-3874, 3891-3893, 3895-3898, 3900-3905, 3917-3923, 3926, 3930, 3931, 3935, 3940, 3945, 3947-3952, 3954-3956, 3961, 3970, 3971, 3976, 4001-4007, 4012, 4013, 4015, 4022, 4028-4034, 4040, 4055, 4059, 4148-4152, 4155, 4156, 4166-4170, 4174-4183, 4236, 4247, 4252-4256, 4261-4265, 4268-4272, 4280-4287, 4291-4294, 4296-4301, 4314
- western tent caterpillar** 3357
- Western United States** 521, 1401, 1999
- western white pine** 1028-1030, 1219, 2299
- white fir** 2-4, 6, 7, 286, 470, 517, 570, 1256, 1297, 2076, 2086, 2098, 2099, 2101, 2102, 2292, 2381, 2784, 2839, 2897, 3122, 3158, 3160, 3162, 3166, 3275-3279, 3323, 3677, 3697, 3848, 4007, 4013
- white grubs** 4222
- white pine blister rust** 524, 1554
- white pine weevil** 194, 337, 556, 921, 1416, 1742, 1812, 2374, 2399, 3083, 4045
- white spruce** 15, 19, 29, 46, 159, 161, 274, 341, 405, 423, 429, 431, 433, 452, 453, 473, 477, 479, 489, 516, 692, 730, 892, 894, 896, 905, 913, 982, 1039, 1200, 1322, 1346, 1361, 1366, 1380, 1392-1394, 1433, 1434, 1488, 1531, 1564, 1579, 1596, 1597, 1629, 1632, 1634, 1635, 1637, 1657, 1744, 1756, 1762, 1816, 1830, 1841, 1890, 1901, 1929, 1942, 1959, 2000, 2052, 2135, 2146, 2209, 2212, 2216, 2220, 2230, 2312, 2321, 2327, 2334, 2335, 2345, 2405, 2407, 2468, 2509, 2516, 2533, 2592, 2691, 2693, 2694, 2757, 2772, 2877, 2892, 2911, 2925, 3008, 3037, 3062, 3210, 3255, 3512, 3537, 3538, 3541, 3542, 3619, 3651, 3739, 3915, 3942, 3967, 3997, 4101, 4107, 4108, 4157, 4159, 4162, 4197, 4203, 4208, 4237, 4242, 4313
- white-throated sparrow** 622, 624, 625
- whitemarked tussock moth** 505, 2623, 3048
- wildlife** 487, 589, 595, 1299, 1724, 1878, 2106, 2735, 2936, 2996, 3940, 3987, 4138, 4250
- wind** 1349, 1832, 2658, 2677, 2705, 2917, 2973, 3338, 3359, 3363, 3372, 3924, 4125, 4133, 4135
- wind damage** 170, 1337, 1454, 3020, 3673
- window-pane traps** 2168, 2174, 2180, 3990
- windspeed** 275, 1669, 3225, 3338, 3372
- winter moth** 690, 2374, 3650
- Wisconsin** 61, 130, 264, 266, 322-328, 333, 336-339, 357, 576, 753, 754, 772, 773, 1073-1077,

- 1337, 1361, 1362, 1364-1366, 1368, 1385,
1502, 1508, 1618, 1620, 1837, 1888, 2012,
2121, 2122, 2128, 2230, 2338, 2546, 2548,
2549, 2554, 2693, 2694, 3005, 3008, 3009,
3012, 3050-3061, 3151, 3154, 3178, 3179,
3196, 3352, 3399, 3426, 3431, 3432, 3533,
3866, 3876, 4022, 4159, 4228-4234, 4249
- within-tree distributions 302, 368, 709, 751,
1086
- wood borers 553, 3673, 4140
- wood density 821
- wood deterioration 243-245, 247-249, 317, 318,
400, 411, 880, 1134, 1200, 1291, 1312, 1877,
2060, 3020, 3174, 3423, 3520, 3594, 3616,
3617, 3620, 3621, 3650, 3673, 3748, 3888,
3958, 3966, 3968, 4027
- wood quality 219, 221, 222, 244, 1071, 1200,
1291, 1292, 1630, 1633, 1636, 1877, 2915,
3427-3429, 3968, 4184
- wood supply 106, 1648, 2219, 2690, 2999, 3326,
3328
- woodwasps 243, 3619, 3620
- Wyoming 130, 175, 180, 190, 195, 225, 343, 369,
374, 572, 766, 770, 827, 890, 1002, 1003, 1020-
1022, 1026, 1085, 1109, 1231-1233, 1235-1239,
1241-1248, 1250, 1252, 1253, 1255, 1275,
1480, 1722, 1723, 1822, 1862, 1869, 1871,
1873, 1960, 1962-1965, 1968, 1969, 1982,
2075, 2111, 2342, 2343, 2367, 2369, 2434,
2492, 2687, 2780, 2781, 2836-2838, 2843,
2922, 2968-2971, 3145, 3200, 3202, 3203,
3534, 3540, 3604, 3625, 3638, 3703, 3707,
3714, 3716, 3719-3722, 3724, 3725, 3729,
3731-3733, 3836, 3838, 3839, 3844, 3845,
3851, 3861, 3867, 3873, 3874, 3894, 3947,
4030, 4166, 4167
- XRD 473 3131
- yellow birch 894, 4110, 4161
- yellow-rumped warbler 623
- yellowheaded spruce sawfly 556, 2345
- Yukon Territory 1220, 1310, 1311, 2899, 2901,
3141, 3143, 3828, 3829, 4253-4256

TAXON INDEX

Abies alba 575, 699, 2956, 3306, 3307, 4317

Abies amabilis 13, 2898

Abies arizonica [*Abies lasiocarpa* var. *arizonica*] 755

Abies balsamea 15, 18, 19, 29, 46, 96, 138, 154, 157, 161, 166, 176, 220, 222, 243, 244, 247-249, 255, 260, 265, 266, 273-276, 285, 289, 290, 306, 309, 317, 358, 367, 382, 405, 409, 412, 417, 422, 423, 429, 431, 435, 438, 441, 442, 446-448, 450-453, 459, 469, 471, 473, 477, 514-516, 551, 628, 635, 651, 671, 699, 738, 739, 775, 842, 888, 892, 894, 896, 905, 917, 919, 937, 951, 969, 979, 982, 984, 1079, 1081, 1082, 1114, 1123, 1142, 1144, 1174, 1176, 1265, 1266, 1291, 1292, 1322, 1336, 1361-1363, 1365, 1378, 1380-1382, 1392-1394, 1419, 1425, 1430, 1435, 1436, 1450-1454, 1485, 1488, 1491, 1504, 1531, 1547, 1568, 1578, 1579, 1597, 1604, 1609, 1624, 1625, 1629, 1631, 1632, 1634, 1635, 1637, 1642, 1647, 1650, 1667, 1698, 1756, 1770, 1781, 1816, 1828, 1841, 1847, 1901, 1938, 1941, 1942, 1951, 1960, 1971, 2000, 2008, 2014, 2034, 2052, 2056, 2060, 2070, 2073, 2122, 2127, 2134, 2135, 2146, 2208-2215, 2217-2220, 2222, 2230, 2232, 2247, 2312, 2327, 2334, 2335, 2345, 2376, 2397, 2408, 2419, 2420, 2449, 2452, 2453, 2456, 2461, 2474, 2487, 2491, 2497, 2505, 2509, 2514, 2518, 2557, 2558, 2564, 2581, 2590, 2593, 2597, 2599, 2600, 2606-2611, 2613, 2619, 2629, 2648, 2649, 2655, 2658, 2676, 2682, 2693, 2694, 2701, 2755, 2763, 2764, 2770, 2785, 2798, 2816, 2875, 2892, 2905-2911, 2925, 2930, 2946, 2947, 2989, 2992, 2994, 2996, 2997, 3000, 3001, 3008, 3009, 3011, 3012, 3019-3021, 3037, 3047, 3065, 3122, 3174, 3175, 3204, 3208, 3255, 3260, 3286, 3300, 3302, 3305, 3309, 3325, 3328, 3337, 3339-3341, 3379-3382, 3398, 3405, 3410, 3414, 3415, 3425, 3428, 3429, 3432, 3445, 3450, 3455, 3456, 3463-3465, 3471, 3476-3478, 3486, 3487, 3506, 3519, 3528, 3529, 3531, 3537, 3538, 3552, 3553, 3561, 3594, 3595, 3609, 3612, 3616, 3617, 3620, 3641, 3687, 3746, 3750, 3792,

3796, 3853, 3990, 3995-3998, 4023, 4081, 4101, 4105, 4107, 4108, 4110, 4120, 4134, 4139, 4157, 4162, 4165, 4197, 4203, 4208, 4212, 4217-4219, 4224, 4237, 4243, 4273, 4274, 4306, 4308, 4309, 4313, 4317

Abies concolor 2-4, 6, 7, 470, 517, 714, 755, 756, 890, 1297, 1874, 2040, 2042, 2076, 2085-2087, 2098-2103, 2381, 2382, 2434, 2439, 2839, 2897, 2914, 3122, 3158, 3160, 3162, 3275-3279, 3323, 3677, 3697, 3848, 4004, 4013, 4166, 4167, 4170

Abies concolor var. *concolor* 3166

Abies grandis 13, 311, 313, 370, 562, 655-657, 666, 701, 709, 712, 714, 934, 1298, 1498, 1861, 1874, 1893, 1903, 2046, 2209, 2269, 2286-2288, 2293, 2351, 2357, 2390, 2393, 2435-2438, 2440, 2722, 2898, 3010, 3014, 3015, 3122, 3323, 3344, 3357, 3539, 3551, 3592, 3787, 3835, 3840, 3848, 3859, 4011, 4033, 4175, 4176, 4184

Abies lasiocarpa 2-4, 6, 13, 30, 311, 314, 343, 344, 369, 370, 701, 714, 742, 756, 890, 1108, 1498, 1874, 2040, 2042, 2076, 2098-2100, 2102, 2103, 2209, 2293, 2357, 2366, 2434, 2439, 2511, 2898, 3158, 3160, 3364, 3365, 3625, 3712, 3835, 3840, 3848, 4033, 4166, 4167, 4170, 4182

Abies lasiocarpa var. *arizonica* 7, 30, 470, 3162, 3166, 4013

Abies lasiocarpa var. *lasiocarpa* 3166

Abies sachalinensis 643, 1885, 1887, 3045

Abies spp. 632, 717, 718, 1088, 1177, 1419, 1661, 1711, 1859, 1968, 2292, 2696, 2838, 3290, 3587, 3588, 3622, 3678, 3685, 3948, 4005, 4181

Absidia repens 1135

Acantholyda nemoralis 2797

Acer rubrum 1889, 2014, 2345, 2858, 3997, 4000, 4309, 4311, 4317

- Acer saccharum* 4110
- Acer spicatum* 894, 1450, 3997
- Acer* spp. 888
- Achaea janata* 3800
- Achytonix epipaschia* 3606
- Acleris emargana* 4059
- Acleris gloverana* 706, 929, 934, 2282, 3357, 3360, 3460, 3606
- Acleris scabrana* 3684
- Acleris variana* 669, 750, 1431, 1813, 1815, 2303, 2629, 2796-2798, 2949
- Acroneuria* spp. 869, 3821
- Acropimpla alboricta* 3779
- Actebia fennica* 3357
- Actia interrupta* 511, 940, 976, 2799, 3310, 3398, 3779, 4156
- Actia* spp. 407, 1986
- Adelges cooleyi* 1233, 1234
- Adelges piceae* 194, 1393, 2374, 2561, 2833, 2994, 3619, 3965
- Adelges* spp. 3349
- Aeneolomia varia saccharina* 824
- Aeschna canadensis* 3832
- Agathis acrobasidis* 1655, 3779
- Agathis bicolor* 940
- Agathis binominata* 3779
- Agria affinis* 556, 830, 836, 867, 925, 1087, 1125, 1827, 2489, 3375
- Agria affinis* [*Pseudosarcophaga affinis*] 714
- Agria housei* 2370, 3310, 3375, 3779, 3787, 3790
- Agria punctata* 3375
- Agria* app. 3375
- Agrion maculatum* 3832
- Agropyron* spp. 4222
- Agrypon variatarsum* 4317
- Alces alces* 29
- Aletia oxygala luteopallens* 3443
- Allonarcys biloba* 3819
- Alnus incana* 2056
- Alnus* spp. 3796
- Alsophila pometaria* 3443
- Amblymerus verditer* [*Mesopolobus verditer*] 511, 940, 1074, 1125, 2798
- Amblymerus* spp. 3779
- Amobia distorta* 1422
- Amphinemura wui* 869
- Amphinemura* spp. 1180, 1556, 3819, 3821
- Amphipyra pyramidoides* 3800
- Amyelois transitella* 1521
- Anagasta kuehniella* 728, 1789
- Anagasta* spp. 1155
- Anas platyrhynchos* 1787

- Anas rubripes* 1786, 1787
- Anatis mali* 3494
- Anatis ocellata* 52
- Anatis quinque decimpunctata* 953
- Ancistrocerus adiabatus* 1851
- Ancistrocerus antilope* 1743, 1851
- Ancistrocerus catskill* 1743, 1851
- Ancistrocerus catskill albophaleratus* 1422
- Ancistrocerus catskill catskill* 1422
- Ancistrocerus tigris tigris* 1422
- Angitia cacoeciae* 209
- Angitia* spp. 836
- Anomogyna elimata* 3443
- Anomogyna perquiritata* 3443
- Anoplonyx canadensis* 1813, 1815
- Anoplonyx luteipes* 1813, 1815, 3443
- Anoplonyx* spp. 3443
- Antheraea pernyi* 2016
- Antheraea polyphemus* 2201
- Anthonomus grandis* 1693
- Anticarsia gemmatalis* 1974
- Apamea lignicolora* 3800
- Apanteles absonus* 2316, 2688
- Apanteles aristoteliae* 3779
- Apanteles dioryctriae* 699
- Apanteles fumiferanae* 53, 322, 334, 421, 427, 437, 443, 486, 511, 554, 643, 699, 714, 784, 786-788, 836, 866-868, 925, 940, 957, 976, 1073, 1074, 1081, 1086, 1090, 1118, 1194, 1559, 1569, 1589, 1590, 1826, 1827, 1859, 1885, 1910, 1915, 2070, 2080, 2104, 2169, 2178, 2316, 2372, 2375, 2385, 2448, 2462, 2486, 2798-2800, 3030, 3274, 3275, 3344, 3378, 3398, 3405, 3408, 3561, 3590, 3740, 3766, 3779, 3787, 3790, 3842, 4180, 4183
- Apanteles milleri* 2316
- Apanteles morrisoni* 1194, 2316, 3779
- Apanteles murinanae* 643, 699, 1885, 2513
- Apanteles petrovae* 2316, 3779
- Apanteles polychrosidis* 3779
- Apanteles renaulti* 2316
- Apanteles* spp. 282, 406, 407, 464, 556, 573, 786, 976, 1314, 1349, 1869, 1915, 2316, 2366, 2398, 2467, 3310, 3809, 3993, 4156, 4317
- Apechthis ontario* 486, 784, 786, 787, 836, 1125, 1569, 1589, 1590, 2375, 2798, 2799, 3030, 3310, 4017
- Apechthis* spp. 407, 2370
- Aphaereta muscae* [*Aphaereta pallipes*] 940
- Aphis nasturtii* 2064
- Aphrophora saratogensis* 337, 338
- Aphytis melinus* 1640
- Apis mellifera* 584
- Aplomya caesar* 511, 755, 867, 940, 957, 976, 1074, 1118, 1986, 3398, 3779, 4235
- Aralia nudicaulis* 3734
- Arceuthobium americanum* 856, 1108

- Arceuthobium douglasii* 3162
- Arceuthobium pusillum* 29, 2056
- Arceuthobium vaginatum cryptopodum* 3602
- Archippus isshikii* 1887
- Archips alberta* 3031
- Archips argyrospilus* 4222
- Archips cerasivoranus* 2062, 2064, 3443, 3446, 3466, 3470, 4206
- Archips fumiferana* [*Choristoneura fumiferana*] 189, 202, 217, 368, 531, 533, 554-557, 670, 836, 928, 940, 1118, 1122, 1123, 1149, 1402, 1447, 1509, 1828, 1829, 1919, 2405, 2407, 2408, 2653, 2758, 2861, 3860, 4158, 4171, 4235
- Archips fumiferana* [*Choristoneura occidentalis*] 570, 572, 573, 670, 836, 996, 1147, 1230, 1244, 1677, 1678, 1868, 1870, 2511, 2783, 4171, 4286
- Archips fumiferana* [*Choristoneura pinus*] 1502, 1704, 2153, 2154
- Archips issikii* 3655
- Archips oporanus* 2512
- Archips pinus* [*Choristoneura pinus*] 533
- Argia moesta* 3832
- Argyrotaenia dorsalana* 706, 712, 3606
- Argyrotaenia klotsi* 3606
- Argyrotaenia provana* 3606
- Argyrotaenia* spp. 3139
- Argyrotoza semipurpurana* 3561
- Armillaria mellea* 1776, 2056, 2996, 3965
- Arthroplea* spp. 870
- Ascaris lumbricoides* 2848
- Atrometus* spp. 511
- Atropellis piniphila* 524, 856
- Autographa biloba* 2974
- Autographa californica* 1974
- Autographa* spp. 3443
- Bacillus cereus* 72, 1652, 1653, 2034, 3449, 3450, 3466, 3469, 3491
- Bacillus entomocidus* [*Bacillus thuringiensis*] 1652
- Bacillus popilliae* 71
- Bacillus sotto* [*Bacillus thuringiensis*] 70
- Bacillus thuringiensis* 27, 40, 71-74, 83, 97, 103, 113, 120, 127, 139, 152, 155, 229, 230, 232, 235, 236, 242, 293, 310, 345, 415, 437, 472, 488, 500, 582, 586, 588, 598, 602, 633, 636, 638, 676, 690, 691, 723, 731, 733-737, 739, 787, 788, 822, 838, 861, 864, 899, 906, 922, 924, 986, 988, 993, 1007, 1036-1038, 1040, 1041, 1044, 1045, 1050-1053, 1055, 1060, 1062, 1112, 1115, 1128, 1138, 1146, 1151, 1158, 1210, 1212, 1213, 1257, 1260-1269, 1275, 1279, 1331, 1347, 1361, 1370, 1526, 1527, 1543, 1552, 1559, 1581, 1594, 1597, 1640, 1644, 1652, 1653, 1700, 1729, 1745, 1761, 1784, 1794, 1803, 1808, 1882, 1893, 1924, 1925, 1941, 1947, 1954, 1958, 1966-1968, 2009, 2023, 2025, 2034, 2078, 2079, 2081, 2097, 2100, 2120, 2124, 2181, 2244, 2252, 2265, 2270, 2274, 2295, 2344, 2364, 2370, 2423, 2489, 2490, 2516, 2520, 2569, 2590-2599, 2602-2611, 2614-2623, 2625-2627, 2680, 2721, 2739, 2745, 2753, 2755, 2756, 2766, 2787, 2798, 2800, 2828, 2829, 2875, 2907, 2943, 2949, 2963-2965, 2990, 3005, 3008, 3009, 3011, 3012, 3049, 3061, 3066,

- 3090, 3156, 3157, 3161, 3163, 3196, 3295,
3368, 3399, 3444, 3445, 3447-3458, 3460-3469,
3471-3481, 3483-3493, 3511, 3516, 3563, 3568,
3572, 3577, 3578, 3622, 3626, 3630, 3631,
3652, 3691, 3694, 3695, 3700, 3701, 3749,
3806, 3814, 3815, 3827, 3844, 3856, 3879,
3880, 3887, 3898, 3909, 3911, 3912, 3917,
3925, 3926, 3948, 3950, 3951, 4022, 4064,
4159, 4290-4292, 4294
- Baetis* spp. 869, 1180, 1556
- Banasa dimidiata* 1889
- Barbara colfaxiana* 1027, 1030, 3346, 3349
- Basiaeschna janata* 3832
- Beauveria bassiana* 1494, 2023, 2225, 2434,
2439, 3563, 3598, 3780, 4256
- Beauveria* spp. 1609, 2224, 2225, 2798
- Bergoldia calypta* 575
- Bergoldiavirus calyptum* 3306
- Bessa harveyi* 2797
- Betula alleghaniensis* 894, 4110, 4161
- Betula lutea* 3997
- Betula papyrifera* 29, 894, 1394, 1756, 2014,
2345, 2420, 2558, 2763, 2858, 3456, 3997, 4161
- Betula* spp. 888, 1661
- Blarina brevicauda* 2655
- Blattella germanica* 3039
- Bombus borealis* 2921
- Bombus ternarius* 2920
- Bombus terricola* 2920, 2921
- Bombus vagans* 2921
- Bombus* spp. 2919, 2920
- Bombyx mori* 71, 2016, 3466, 3521
- Bonasa umbellus* 29, 1709, 2656
- Brachymeria compsilurae* 511
- Brachymeria intermedia* 976, 2072, 2523, 3779,
3833
- Brachymeria ovata* 1125, 4017
- Bracon cushmani* 3779
- Bracon politiventris* 1590, 2378, 2434, 2439,
3779
- Bracon* spp. 836, 1480
- Bucculatrix canadensisella* 1756
- Bufo americanus* 589
- Bupalus piniarius* 2797
- Cacoecia fumiferana* [*Choristoneura*
fumiferana] 85, 169, 176, 177, 194, 534-537,
541-543, 754, 880, 881, 1469, 1485, 1503,
1507, 1650, 2038, 2056, 2206, 2859, 3271,
3520, 3657, 3663, 3670, 3673, 3751, 4140
- Cacoecia fumiferana* [*Choristoneura lambertiana*
ponderosana] 287
- Cacoecia fumiferana* [*Choristoneura*
occidentalis] 175, 225, 286, 316, 1225, 1229,
1231, 1232, 1235-1239, 1241-1243, 1245-1248,
1252, 1253, 1255, 1990, 2890, 3201, 3203,
3861, 4147
- Cacoecia fumiferana* [*Choristoneura*
pinus] 1701-1703
- Cacoecia fumiferana* [*Choristoneura* spp.] 2057
- Cacoecia fumiferana* var. *lambertiana*
[*Choristoneura lambertiana*] 190
- Cacoecia histrionana* 643, 1399

- Cacoecia histrionana* [*Choristoneura histrionana*] 124
- Cacoecia murinana* [*Choristoneura murinana*] 124
- Caenorhabditis elegans* 2848
- Calathus ingratus* 3032
- Calliephialtes comstockii* [*Ephialtes comstockii*] 4017
- Calliergon schreberi* 2056
- Calosoma frigidum* 3032, 3255
- Cambarus bartoni* 1043, 1065, 2200, 3420
- Cammarus* spp. 870
- Camnula pellucida* 2057
- Campaea perlata* 1813, 1815
- Camponotus herculeanus* 1855, 3242, 3243
- Camponotus laevigatus* 4297, 4298, 4300
- Camponotus modoc* 4297, 4298, 4300
- Camponotus novaeboracensis* 52, 1276, 3242, 3243
- Camponotus pennsylvanicus* 3243
- Camponotus vicinus* 4297, 4298, 4300
- Camponotus* spp. 4299
- Campoplex hyalinus* 4017
- Campoplex* spp. 511, 714, 786, 866, 868, 1590, 1655, 3779
- Canachites canadensis* 1709
- Canis lupus* 29
- Cardiaspina albitextura* 2332, 2797
- Carduelis pinus* 1840, 2279
- Carpocapsa pomonella* 2225
- Carpodacus purpureus* 2396, 2655
- Carulaspis visci* 2374
- Catharus ustulata* 888
- Catolaccus aeneoviridis* 1655
- Catostomus catostomus* 2960
- Catostomus commersoni* 2960
- Cecidostiba burkei* 2797
- Celithemis elisa* 3832
- Cephaloglypta laricis* 643, 1885, 3045
- Cephaloglypta murinanae* 643, 2513
- Cephalosporium* spp. 1609
- Ceratocystis minor* 1821
- Ceratocystis* spp. 1821
- Ceromasia auricaudata* 76, 571, 573, 574, 714, 755, 831, 836, 867, 925, 1559, 1589, 1590, 2370, 2385, 3274, 3275, 3779, 3787, 3790, 3842, 4171
- Ceromasia aurifrons* 3779
- Ceromasia* spp. 1480
- Ceroplastes ceriferus* 2797
- Certhia familiaris* [*Certhia americana*] 2655
- Chamaedaphne calyculata* 2056
- Charadra circuliifera* 3800
- Charletonia* spp. 3800
- Charmon gracilis* 1569, 3779

- Chermes abietis* [Adelges abietis] 3661
- Chermes piceae* 2629
- Chermes similis* 3661
- Chionodes abella* 3606
- Chlamydomonas reinhardtii* 1195, 4161
- Chorinaeus excessorius* 3779
- Chorinaeus longicalcar* 3779
- Choristoneura biennis* 54, 55, 58, 143, 377, 379, 395, 561, 614, 616, 617, 647, 687, 689, 695, 851, 853, 900, 903, 926, 1091-1095, 1218, 1308, 1309, 1311, 1403, 1522, 1605, 1607, 1608, 1613, 1718, 1788, 1814, 1816, 1856, 1887, 1980, 2003, 2023, 2024, 2045, 2270, 2300, 2325, 2377, 2537, 2562, 2584, 2589, 2851, 2900, 2901, 2933, 3141, 3142, 3238, 3248, 3249, 3357, 3388, 3501, 3502, 3596-3598, 3632, 3688, 3829, 4253, 4256, 4263, 4266, 4267
- Choristoneura carnana* 1608, 2086, 2933
- Choristoneura carnana californica* 922-924, 1608, 1706, 2023-2025
- Choristoneura conflictana* 856, 900, 903, 1444, 1756, 1813, 1815, 2094, 2270, 2300, 2378, 2826, 2827, 2935, 3122, 3167, 3614, 3615, 3781, 4060, 4063
- Choristoneura diniana* 1788
- Choristoneura diversana* 643, 900, 905, 1788, 1885, 1887, 2300, 2798, 3045, 3655
- Choristoneura fractivittana* 2094, 2935, 3167, 3781, 4060
- Choristoneura fumiferana* 1, 8, 12, 14-25, 29, 36, 38-40, 43-46, 48, 58, 59, 61, 62, 69-73, 88, 96, 100, 101, 118, 131-138, 140-144, 147, 150, 153-157, 159-161, 165, 166, 182, 204-207, 215, 218, 220-223, 238, 244, 248-250, 255, 258-260, 265-267, 273-276, 281, 285, 288-290, 292-298, 300, 301, 304-306, 308, 309, 317, 321, 323, 340, 346, 347, 351-356, 358-362, 364, 367, 375-378, 381-396, 405, 409, 411, 412, 416-418, 422, 423, 429-431, 433-435, 438, 441, 442, 445-456, 459, 463, 468, 469, 471, 473, 476, 477, 485, 486, 488, 504, 507, 514-516, 529, 530, 532, 540, 544, 551, 552, 561, 566-569, 575, 582, 584-587, 589-591, 594-596, 598-600, 610, 612-617, 622-626, 628, 629, 634-638, 640, 643, 646-651, 657, 667, 669, 671, 674, 681, 682, 684-687, 689-691, 693-695, 698, 699, 713, 720-722, 725, 728, 737-739, 749-751, 755, 758, 763, 775-778, 780-792, 800, 816, 819, 820, 823, 824, 829-835, 838, 842, 843, 848, 850, 858, 869, 870, 873, 877, 884, 888, 889, 892, 894, 896, 898-907, 911, 912, 914, 915, 917, 919-921, 926, 936, 947, 951, 955, 957, 969, 976-979, 981-989, 992, 993, 1013, 1032-1038, 1041, 1043, 1050, 1051, 1063-1065, 1067, 1069, 1079-1083, 1087, 1112-1114, 1116, 1117, 1119, 1124, 1127, 1131, 1132, 1136, 1137, 1139-1145, 1150, 1152, 1153, 1155, 1161-1170, 1172-1180, 1184, 1192, 1195, 1197, 1199, 1201-1204, 1208, 1214, 1218, 1220-1222, 1260-1262, 1265-1269, 1291, 1296, 1301, 1305, 1308, 1313, 1315-1317, 1319-1323, 1330, 1331, 1333-1336, 1341, 1346, 1347, 1358, 1359, 1361-1366, 1375-1378, 1380-1383, 1392-1394, 1396, 1398, 1399, 1402-1407, 1409-1411, 1419-1425, 1427, 1429, 1430, 1434, 1435, 1439, 1444, 1450-1452, 1454, 1458, 1459, 1461, 1462, 1476-1478, 1482, 1487, 1489, 1491, 1495, 1504, 1511, 1517, 1518, 1521-1523, 1526, 1527, 1529-1532, 1536-1540, 1544, 1545, 1547, 1548, 1550, 1556-1558, 1560, 1566-1568, 1570, 1573, 1578-1581, 1594, 1595, 1597-1605, 1607-1610, 1612-1616, 1618-1620, 1623, 1624, 1626, 1628-1636, 1640, 1645, 1648-1652, 1659, 1661, 1666-1668, 1670, 1671, 1674-1676, 1679, 1685, 1687-1689, 1695-1699, 1705, 1706, 1710, 1713, 1716, 1718, 1720, 1723, 1726, 1728-1730, 1735-1742, 1744-1747, 1749-1752, 1756-1773, 1776, 1777, 1779-1782, 1785-1788, 1791, 1793, 1794, 1796-1798, 1802, 1803, 1808, 1810, 1813-1817, 1824, 1826, 1827, 1830-1833, 1836, 1840-1843, 1847-1857, 1879, 1882, 1885,

1886, 1889-1891, 1897, 1898, 1901, 1902,
 1908-1912, 1915, 1916, 1918, 1922, 1923,
 1937, 1938, 1940-1943, 1945-1947, 1949, 1951-
 1957, 1966, 1967, 1970, 1971, 1974, 1976,
 1978-1981, 1984, 1987, 1988, 2000, 2008,
 2010-2012, 2016, 2017, 2020-2026, 2034-2037,
 2049-2052, 2059-2064, 2070, 2072, 2073, 2079-
 2082, 2088-2094, 2116, 2120-2123, 2125-2128,
 2130, 2135-2144, 2156-2158, 2160, 2166, 2169,
 2179, 2183-2190, 2192, 2197, 2200, 2201,
 2205, 2207-2215, 2217-2223, 2225-2232, 2236-
 2245, 2247, 2265, 2270-2272, 2276-2278, 2300,
 2303, 2305-2308, 2312, 2314-2316, 2322, 2325,
 2327-2329, 2332-2335, 2345-2347, 2351, 2358,
 2371, 2373, 2374, 2376, 2377, 2394, 2396,
 2398, 2400-2402, 2411-2413, 2415-2419, 2422,
 2423, 2433, 2443, 2447-2449, 2451-2454, 2456,
 2458-2464, 2466, 2468-2470, 2472, 2474-2477,
 2483, 2485-2487, 2491, 2493, 2497, 2504,
 2505, 2509, 2512-2516, 2518, 2523, 2524,
 2526-2531, 2533, 2534, 2536, 2537, 2540,
 2543, 2546, 2548, 2549, 2554, 2556-2559,
 2561-2567, 2571-2574, 2576-2582, 2590-2595,
 2597-2625, 2627, 2629, 2630, 2633, 2634,
 2637, 2639-2642, 2645-2649, 2651, 2654-2658,
 2660, 2662, 2664-2673, 2675-2679, 2682, 2688,
 2690, 2692-2695, 2700, 2701, 2703, 2704,
 2708, 2711, 2714, 2716, 2723-2726, 2728-2731,
 2733-2735, 2737, 2739-2742, 2744, 2746, 2747,
 2753, 2760, 2763, 2764, 2770, 2781, 2785,
 2786, 2788, 2790, 2794, 2795, 2797-2800,
 2802-2810, 2812-2814, 2816, 2820-2824, 2826-
 2833, 2844, 2845, 2848-2851, 2853, 2854,
 2856-2858, 2860, 2875, 2882-2889, 2891, 2892,
 2896, 2899-2902, 2905-2912, 2917, 2920, 2923-
 2928, 2930, 2932, 2933, 2935, 2937, 2943,
 2946, 2947, 2949, 2951, 2956, 2972-2977,
 2979-2986, 2988-2992, 2994, 2996-2999, 3001,
 3005, 3008, 3009, 3011, 3012, 3019-3021,
 3028, 3029, 3031-3037, 3043-3045, 3047, 3061-
 3063, 3065, 3067-3072, 3074, 3076, 3078-3091,
 3093, 3103, 3104, 3113, 3122, 3141-3144,
 3146-3148, 3151, 3164, 3165, 3167-3177, 3181,
 3183-3185, 3187, 3188, 3190, 3195, 3196,
 3199, 3204, 3206-3216, 3218, 3219, 3222-3235,
 3237, 3238, 3241-3261, 3264, 3268, 3273,
 3283, 3285-3289, 3300-3302, 3305, 3308-3310,
 3317-3319, 3321, 3324, 3325, 3328, 3330,

3333, 3335, 3337, 3338, 3340, 3341, 3352,
 3357, 3361, 3365, 3372, 3374, 3375, 3379,
 3383, 3384, 3386-3388, 3390, 3393, 3395,
 3396, 3398, 3405, 3406, 3408-3410, 3414,
 3415, 3417, 3419, 3421, 3422, 3424, 3428,
 3429, 3432-3438, 3440, 3443, 3445-3453, 3455-
 3472, 3474-3478, 3480-3492, 3494, 3497-3500,
 3506-3514, 3519, 3521-3523, 3526-3529, 3532,
 3535, 3537, 3538, 3541, 3542, 3544, 3546,
 3549, 3552-3554, 3556, 3558-3566, 3574, 3575,
 3578-3582, 3585, 3591, 3594-3598, 3607-3609,
 3611, 3612, 3614-3620, 3632, 3635, 3641,
 3649-3651, 3653, 3669, 3674, 3681, 3683,
 3684, 3687, 3688, 3692, 3725, 3728, 3736-
 3738, 3740-3742, 3744-3748, 3750, 3760, 3761,
 3764, 3766, 3767, 3769-3772, 3776, 3779-3781,
 3785, 3786, 3796, 3802, 3804, 3809, 3828-
 3833, 3837, 3839, 3850, 3851, 3853, 3876-
 3880, 3894, 3906, 3910, 3941, 3960, 3961,
 3963-3965, 3969, 3970, 3972-3975, 3977, 3979,
 3981, 3985, 3988, 3990, 3992, 3995-3998,
 4000, 4001, 4008, 4010, 4017-4019, 4022,
 4023, 4026, 4027, 4037, 4038, 4044, 4046,
 4048, 4049, 4051, 4052, 4054, 4057, 4059-
 4065, 4074, 4080, 4081, 4089, 4092, 4104-
 4117, 4120-4123, 4125, 4127-4132, 4134-4136,
 4138, 4139, 4142, 4157, 4159, 4162, 4163,
 4165, 4169, 4172, 4173, 4178, 4187-4210,
 4212-4221, 4223, 4224, 4228-4232, 4237, 4239,
 4240, 4243-4246, 4253, 4256, 4258, 4266,
 4267, 4273-4275, 4277, 4290, 4304, 4305,
 4307, 4308, 4310-4313, 4315, 4317, 4318

Choristoneura fumiferana [*Choristoneura biennis*] 1584, 1585, 3358, 3370

Choristoneura fumiferana [*Choristoneura occidentalis*] 180, 350, 484, 577, 604, 631,
 711, 714, 715, 742, 756, 808-815, 847, 925,
 1000, 1002, 1003, 1008, 1021, 1027, 1085,
 1088, 1251, 1270, 1278, 1283, 1285, 1287,
 1318, 1412, 1496, 1497, 1691, 1693, 1694,
 1709, 1724, 1753, 1864, 1866, 1869, 1871-
 1873, 1962, 1968, 2040, 2042, 2096, 2106,
 2339, 2341-2343, 2363, 2367, 2432, 2434,
 2439, 2538, 2702, 2780, 2782, 2847, 3389,
 3525, 3534, 3593, 3703-3707, 3711-3714, 3716-
 3720, 3722-3724, 3726, 3727, 3729-3733, 3834-

- 3836, 3852, 3867, 3870, 3871, 3893, 3895,
3904, 3908, 3918-3920, 3923, 3931, 3945,
3947, 3954-3956, 4011, 4015, 4028, 4029,
4031, 4032, 4055, 4148, 4150, 4151, 4154,
4156, 4166-4168, 4170, 4175, 4280
- Choristoneura fumiferana* [*Choristoneura
retiniana*] 2934
- Choristoneura houstonana* [*Cudonigera
houstonana*] 1654-1656, 1788, 2935
- Choristoneura lambertiana* 179, 180, 215, 700,
770, 926, 1024, 1110, 1218, 1473, 1492, 1613,
1649, 1722, 1723, 1788, 1823, 1962, 1963,
1980, 2365, 2368-2370, 2851, 2901, 2902,
2914, 2932, 2933, 3142, 3632, 3785, 3828,
3829, 3919
- Choristoneura lambertiana californica* 2147
- Choristoneura lambertiana lambertiana* 1649
- Choristoneura lambertiana ponderosana* 1480,
2047, 3122, 3602-3604, 3785
- Choristoneura lambertiana subretiniana* 215,
1649, 3571, 3785
- Choristoneura murinana* 482, 575, 610, 611,
643, 699, 900, 914, 931, 977, 1398, 1428, 1775,
1780, 1788, 1885, 1891, 2016, 2120, 2300,
2449, 2512, 2513, 2624, 2798, 2956, 3164,
3306, 3307, 4315, 4317
- Choristoneura obsoletana* 2094, 3167, 3615,
3781
- Choristoneura occidentalis* 2-7, 13, 32-35, 54-57,
65-68, 153, 171, 179, 227, 234-237, 239-241,
311-315, 343-345, 369, 370, 470, 483, 487, 491,
493-498, 500-502, 517, 518, 521, 523, 561, 562,
602, 605, 607-609, 613-617, 630, 632, 633, 647,
653-656, 658-666, 680, 687, 689, 701-707, 709,
710, 712, 713, 716-718, 744, 746, 747, 759,
760, 764-767, 770, 771, 802, 849, 851-855, 857,
889, 890, 893, 899, 900, 905-907, 910, 914,
920, 923, 926, 929, 930, 932-936, 998, 1019,
1020, 1022-1026, 1030, 1090, 1095, 1096,
1108, 1110, 1131, 1157, 1182, 1193, 1215,
1218, 1219, 1276, 1277, 1279-1282, 1286,
1298, 1308-1311, 1327-1329, 1360, 1381, 1386,
1387, 1401, 1403, 1441, 1473, 1475, 1479,
1480, 1492, 1498, 1518, 1521, 1541, 1545,
1546, 1551, 1559-1561, 1571, 1582, 1583,
1586, 1588-1593, 1605, 1607, 1608, 1612,
1613, 1639-1641, 1649, 1660, 1664, 1699,
1700, 1706, 1711, 1718, 1722, 1788, 1789,
1816, 1822, 1823, 1831, 1842, 1843, 1856,
1861, 1862, 1874, 1892, 1893, 1898, 1903,
1904, 1906, 1907, 1913, 1914, 1921, 1960,
1963, 1969, 1980-1986, 1991-1998, 2002, 2003,
2005, 2023-2026, 2043, 2044, 2046, 2047,
2055, 2075-2077, 2082, 2084-2087, 2097-2103,
2105, 2107, 2109-2112, 2115, 2117-2119, 2147,
2150, 2151, 2209, 2269, 2273, 2274, 2279,
2281-2290, 2293-2295, 2300, 2301, 2351, 2353-
2357, 2362, 2364, 2366, 2370, 2377, 2378,
2380-2388, 2390-2393, 2435-2438, 2440, 2441,
2521, 2522, 2524-2526, 2535, 2537, 2570,
2585, 2587, 2622, 2686, 2687, 2696, 2722,
2777, 2819, 2835-2843, 2846, 2893, 2898,
2916, 2922, 2933, 2963-2966, 2968-2971, 2988,
2993, 3007, 3010, 3014-3017, 3038-3042, 3094,
3097-3100, 3106-3109, 3111-3116, 3118-3140,
3145, 3156-3164, 3166, 3180, 3198, 3205,
3238, 3248, 3249, 3269, 3270, 3274-3276,
3278, 3279, 3281, 3283, 3284, 3291, 3293,
3294, 3296, 3297, 3299, 3311-3313, 3323,
3325, 3332, 3344, 3346-3349, 3357, 3359-3361,
3368, 3371, 3373, 3378, 3383, 3387, 3388,
3503, 3504, 3539, 3550, 3551, 3556, 3557,
3587-3590, 3592, 3596-3598, 3601, 3605, 3606,
3623-3625, 3629-3635, 3637, 3638, 3640, 3641,
3644, 3676-3679, 3685, 3686, 3688, 3693-3702,
3725, 3735, 3749, 3752, 3756-3759, 3773,
3778, 3785, 3787, 3789, 3790, 3838, 3840,
3841, 3843-3846, 3848, 3849, 3854, 3858,
3859, 3873, 3874, 3897, 3898, 3900, 3902,
3903, 3905, 3917, 3949-3952, 3970, 3971,
4001-4007, 4013, 4021, 4022, 4033, 4040,
4059, 4065, 4174, 4176-4183, 4252, 4253,
4255, 4256, 4261-4265, 4268-4272, 4282, 4283,
4294, 4299, 4300
- Choristoneura orae* 561, 614, 616, 687, 926,
1218, 1308, 1403, 1525, 1605, 1607, 1608,

- 1613, 1718, 1788, 1980, 2023, 2025, 2584,
2933, 3238, 3388, 4253, 4256
- Choristoneura parallela* 3167
- Choristoneura pinus* 42, 47, 51-53, 182, 270,
279, 282, 284, 322, 325, 329-334, 338, 339,
356, 519, 520, 540, 646, 648, 667, 669, 674,
686, 697, 721, 873, 877, 889, 926, 989, 990,
994, 995, 1073-1077, 1089, 1125, 1194, 1348-
1351, 1384, 1404, 1407, 1421, 1511, 1649,
1671, 1674, 1705, 1706, 1723, 1788, 1821,
1825, 1835, 1837, 1839, 1856, 1875, 1962,
1981, 2026-2033, 2068, 2158, 2159, 2205,
2207, 2270, 2300, 2323, 2324, 2326, 2338,
2358, 2418, 2442, 2496, 2498-2501, 2507,
2508, 2537, 2670-2673, 2732, 2733, 2743,
2744, 2759, 2797, 2826, 2827, 2884, 2932,
2933, 2955, 3028, 3043, 3061, 3103, 3122,
3167, 3169, 3170, 3172, 3179, 3192, 3213,
3229, 3238, 3301, 3331, 3418, 3435, 3442,
3506-3508, 3510, 3558, 3563, 3581, 3686,
3688, 3761, 3785, 3828, 3876, 3906, 4017,
4091, 4216, 4228-4232, 4279
- Choristoneura pinus maritima* 1403, 1613, 1649,
1980
- Choristoneura pinus pinus* 61, 133-136, 218,
283, 324, 326-328, 337, 375, 376, 510, 529,
530, 613, 615, 682, 683, 687, 689, 772, 773,
823, 900, 991, 992, 1131, 1202, 1221, 1222,
1403, 1558, 1605, 1613, 1649, 1695, 1696,
1755, 1773, 1797, 1813, 1815, 1831, 1838,
1842, 1843, 1980, 2094, 2147, 2227-2229,
2307, 2502, 2503, 2562, 2563, 2850, 2851,
2879, 2900, 2931, 3113, 3141, 3142, 3168,
3173, 3178, 3207, 3383, 3385, 3388, 3440,
3502, 3596, 3597, 3613-3615, 3770-3772, 4112-
4116, 4251
- Choristoneura retiniana* 900, 923, 931, 1608,
2023, 2084-2087, 3323, 3388, 3632, 4002-4007
- Choristoneura rosaceana* 610, 900, 931, 2012,
2094, 2300, 2826, 2827, 2846, 2956, 3167,
3615, 3781, 4063, 4222
- Choristoneura spaldingiana* 2933
- Choristoneura subretiniana* 1613, 1788, 1980
- Choristoneura viridis* [*Choristoneura
retiniana*] 616, 680, 706, 929, 930, 932,
1096, 1297, 1403, 1492, 1605, 1613, 1706,
1788, 1798, 1980, 2025, 2897, 2914, 3113,
3122, 3238, 3249, 3281-3283, 3635, 3688, 3785
- Choristoneura zapulata* 3167
- Choristoneura* spp. 63, 64, 203, 232, 292, 335,
592, 593, 667, 669, 763, 818, 827, 856, 935,
1090, 1130, 1155, 1205, 1302, 1404, 1408,
1471, 1474, 1532, 1549, 1572, 1611, 1613,
1650, 1671, 1717, 1835, 1977, 2012, 2013,
2148, 2149, 2319, 2328, 2389, 2570, 2586,
2588, 2596, 2735, 2933, 2935, 2947, 2950,
2952, 2979, 3003, 3103, 3248, 3572, 3584,
3586, 3614, 3615, 3674, 3682, 3781, 3783,
3864, 3865, 3976, 4009, 4053, 4074, 4153,
4173, 4184, 4255, 4316
- Choristoneura* spp. [*Choristoneura pinus*] 2067
- Chrysis* spp. 1422
- Chrysomela crotchii* 1813, 1815
- Chrysomya cassandrae* 2056
- Chrysomya pirolata* 856
- Chrysopa carnea* 1640
- Chrysops niger* 3443
- Cladonia* spp. 4222
- Clepsia persicana* 3606
- Clethrionomys gapperi* 594, 2655
- Clethrionomys gapperi gapperi* 597
- Clinocentrus fumiferanae* 2688, 3779
- Clinocentrus* spp. 3561
- Clintonia borealis* 1566, 2920, 3734

- Clostridium* spp. 72, 1195
- Cnephasia pumicana* 2956
- Coccothraustes vespertina* 2279
- Coccygomimus disparis* 1885
- Coccygomimus turionellae* 1885
- Colaptes auratus* 4314
- Coleophora laricella* 2093, 2374, 2797, 2833, 3094, 3291, 4178
- Coleotechnites milleri* 921
- Coleotechnites starki* 3357
- Coleotechnites* spp. 706, 3606
- Colias philodice* 2016
- Compsilura concinnata* 573, 3779
- Conidiobolus* spp. 3973
- Coniophora puteana* 245, 248
- Conoblasta fumiferanae* [*Glypta fumiferanae*] 1859
- Conophthorus banksianae* 4222
- Conophthorus monticolae* 1030
- Conophthorus* spp. 1507
- Contarinia washingtonensis* 1021, 1027, 3346
- Contarinia* spp. 1030, 3031
- Cordulegaster diastatops* 3832
- Cordulegaster maculatus* 3832
- Cornus alternifolia* 3734
- Cornus canadensis* 1566, 3734
- Cornus stolonifera* 3734
- Corticeus* spp. 1821
- Cosmarium* spp. 1195
- Cottus cognatus* 2015
- Cottus* spp. 1471
- Coturnix coturnix japonica* 1315
- Crangonyx richmondensis* 1458
- Cremastus epagoges* 511
- Crocigrapha normani* 3443
- Croesia semipurpurana* 2833
- Cronartium coleosporioides* 2931
- Cronartium comandrae* 2931
- Cronartium fusiforme* 921
- Crymodes devastator* 2201
- Cryptococcus fagi* 194
- Cryptus leechi* 2315
- Cudonigera houstonana* 2935
- Culex tarsalis* 2797
- Culicoides* spp. 1952
- Cyanocitta cristata* 2655, 2798
- Cyllene robiniae* [*Megacyllene robiniae*] 1507
- Cymindis cribricollis* 3032
- Cypripedium acaule* 2921
- Cyzenis incrassata* 1590
- Danaus plexippus* 2201

- Daphnia pulex* 1216
- Dasineura canadensis* 3780
- Dasineura rachiphaga* 3780
- Dasychira plagiata* [*Paraorgyia plagiata*] 326, 337
- Dasychira plagiata* [*Parorgyia plagiata*] 338
- Daucus carota* 4222
- Dendragapus obscurus* 1318, 1709, 2702
- Dendrocopos pubescens* [*Picoides pubescens*] 2655
- Dendrocopos villosus* [*Picoides villosus*] 2655
- Dendroctonus barberi* [*Dendroctonus brevicomis*] 3534
- Dendroctonus brevicomis* 194, 921, 935, 1979, 2797, 2893
- Dendroctonus engelmanni* [*Dendroctonus rufipennis*] 1817, 3534
- Dendroctonus frontalis* 194, 921, 2325, 2797
- Dendroctonus monticolae* [*Dendroctonus ponderosae*] 3534
- Dendroctonus piceaperda* [*Dendroctonus rufipennis*] 320, 2374, 2629, 2691
- Dendroctonus ponderosae* 194, 364, 606, 607, 767, 856, 1979, 2362, 2441, 2893, 3534
- Dendroctonus pseudotsugae* 856, 1678, 1870, 1873, 2025, 2116, 2362, 2441, 2893, 3534
- Dendroctonus rufipennis* 856, 921, 2797
- Dendroctonus valens* 1821
- Dendroctonus* spp. 194, 1660, 2833
- Dendroica caerulescens* 888, 1785
- Dendroica castanea* 590, 622-624, 888, 1956, 2160, 2655, 2666, 2797
- Dendroica coronata* 623, 888, 2160, 2655
- Dendroica fusca* 623, 624, 888, 1785, 2160, 2655, 2797
- Dendroica magnolia* 622, 624, 888, 1956, 2655
- Dendroica pensylvanica* 888
- Dendroica striata* 2655
- Dendroica tigrina* 2160, 2396, 2655, 2666
- Dendroica virens* 888, 2160, 2655
- Dendroica* spp. 2566, 2798
- Diadegma* spp. 1590, 2513, 3310
- Dichelia histrionana* 2512
- Dicladocerus* spp. 556, 3779
- Dicrocheles* spp. 3800
- Dictyna phylax* 52, 3047
- Dictyna volupis* [*Dictyna sublata*] 1859
- Didymops transversa* 3832
- Didymuria violescens* 2797
- Dioryctria abietella* 2206
- Dioryctria abietivorella* [*Dioryctria abietella*] 1021, 1027
- Dioryctria pseudotsugella* 1090
- Dioryctria reniculella* [*Dioryctria reniculelloides*] 217, 2206, 2303, 2378, 2383, 2402, 2607, 2798, 3762, 3830, 4025
- Dioryctria reniculelloides* 706, 1559, 1762, 2282, 2723, 3007, 3308, 3515, 3517, 3541-3544, 3965

- Dioryctria* spp. 1030, 1507, 1995, 2366, 3346, 3349, 3606
- Dipogon sayi sayi* 1422
- Diprion frutetorum* 2374
- Diprion hercyniae* [*Gilpinia hercyniae*] 70, 487, 2016, 2225, 2332, 2374, 3031, 3443
- Diprion polytomum* 194, 1485
- Diprion sertifer* 2797
- Diprion similis* 2374, 2797
- Dirophanes banksianae* [*Phaeogenes maculicornis hariolus*] 47, 53
- Dirophanes spinicoxus* 47
- Dirophanes yezoensis* 1885
- Dolichogenidea absona* 3779
- Dorocordulia libera* 3832
- Dorocordulia* spp. 3832
- Dromogomphus* spp. 3832
- Drosophila melanogaster* 1645
- Drosophila* spp. 1606, 4304
- Dryocoetes confusus* 2362
- Dryocopus martius* 2797
- Dryocopus pileatus* 2797
- Earomyia* spp. 1030
- Echinodontium tinctorium* 1298
- Ectropis crepuscularia* 3357
- Ectropis* spp. 1155
- Egira simplex* 3606
- Elachertus aeneoniger* 3779
- Elachertus cacoeciae* 2093, 2467
- Elasmus atratus* 1590, 1655
- Ellopiia fiscellaria* [*Lambdina fiscellaria*] 1507
- Ellopiia prosapiaria* 2797
- Ellopiia somniaria* [*Lambdina somniaria*] 1507
- Empidonax flaviventris* 2655
- Empidonax hammondii* 2279
- Empidonax minimus* 2655
- Empidonax oberholseri* 2279
- Empria* spp. 2057
- Empusa* spp. 71, 2224, 2798
- Enallagma civile* 3832
- Enallagma corium* 3832
- Enallagma ebrium* 3832
- Enallagma hageni* 3832
- Enallagma* spp. 3832
- Enargia decolor* 1813, 1815
- Endocronartium harknessii* 856, 2931
- Endothia parasitica* 2797
- Entomophthera aulicae* 2889
- Entomophthora egressa* 784, 1135, 1137, 2089, 2798, 3973
- Entomophthora sphaerosperma* 784, 1609, 2265, 2798, 3972, 3973, 3975

- Entomophthora* spp. 786, 787, 1215, 1609, 1803, 2270, 2537, 3563, 3974
- Entomopoxvirus* spp. 379
- Enypia griseata* 3606
- Enytus montanus* 3779, 3787, 3790, 3842
- Enytus* spp. 1590, 2513
- Epeorus* spp. 869, 1180
- Ephemerella* spp. 869
- Ephialtes annulicornis* 3779
- Ephialtes hispae* 1125
- Ephialtes ontario* 714, 788, 940, 976, 1074, 1118, 2070, 3398, 3779, 3787, 3790, 3842
- Ephialtes quadridentatus* 482
- Ephialtes sanguinipes* [*Coccygomimus sanguinipes sanguinipes*] 316
- Ephialtes* spp. 1422
- Epiblema nigricana* 2512
- Epinotia aciculana* 3655
- Epinotia meritana* 3534
- Epinotia nanana* 2056
- Epitheca canis* 3832
- Epitheca cynosura* 3832
- Epitheca spinigera* 3832
- Epitheca* spp. 3832
- Epiurus atrocoxalis* [*Scambus atrocoxalis*] 316
- Epiurus innominatus* [*Scambus transgressus*] 1859
- Epizeuxis aemula* 3800
- Ernarmonia conicolana* 2797
- Erynia crustosa* 3064
- Erynia radicans* 2089, 2536, 2889, 3532
- Escherischia coli* 142
- Estigmene acraea* 905
- Estigmene acrea* 3330
- Eubadizon gracile* 867
- Eucordylea atrupictella* 3046
- Eucosma sonomana* 934-936, 2035, 2956, 3094
- Euexorista futilis* 511
- Euglena gracilis* 1137
- Euodynerus leucomelas* 1851
- Euphorocera* spp. 1722
- Eupithecia catalinata* 3606
- Eupithecia filmata* 3443
- Eupoecilia ambiguella* 2956
- Euxoa ochrogaster* 2062
- Evagora starki* [*Coleotechnites starki*] 2374
- Evagora* spp. 3046
- Evergestis forficalis* 2956
- Exartema* spp. 4059
- Exeristes comstockii* 3779
- Exochus nigripalpis tectulum* 511, 3779
- Exochus pallipes* [*Exochus pleuralis*] 511

- Exochus* spp. 2652
- Exorista vulgaris* 1859
- Exoteleia dodecella* 2064
- Exoteleia pinifoliella* 2374
- Fagus grandifolia* 888, 3398
- Ficedula hypoleuca* 2797
- Fomes annosus* 524, 921, 1821, 1824, 3866
- Fomes pini* 1393, 2056
- Fomes pinicola* 245, 248
- Formica accreta* 4297, 4298, 4300
- Formica criniventris* 1276
- Formica exsectoides* 1276
- Formica fusca* 1835
- Formica haemorrhoidalis* 660, 1835
- Formica lasioides* 4297, 4298, 4300
- Formica lugubris* 1257, 1319, 2417
- Formica montana* 1835
- Formica neorufibarbis* 4297, 4298, 4300
- Formica obscuripes* 1276, 1835, 4297, 4298, 4300
- Formica obscuriventris* 1835
- Formica podzolica* 4297, 4298, 4300
- Formica schaufussi* 1835
- Formica* spp. 4299
- Galleria mellonella* 2062, 2523, 3556, 3557, 3566, 3833
- Garrulus glandarius* 2797
- Gelechia betulae* 2956
- Gelis apantelis* 3310
- Gelis tenellus* 1125, 3310, 4017
- Gelis* spp. 3310, 3779
- Geothlypis trichas* 590, 888
- Gilpinia hercyniae* 690, 2056, 2629, 2640, 2797, 2798
- Glugea fumiferanae* [*Nosema fumiferana*] 1810
- Glypta cicatricosa* 4317
- Glypta fumiferanae* 53, 316, 421, 427, 437, 443, 486, 511, 555, 714, 716, 744, 755, 784, 786-788, 836, 866-868, 925, 957, 976, 1074, 1081, 1086, 1090, 1118, 1125, 1194, 1349, 1480, 1559, 1569, 1589, 1590, 1826, 1827, 1910, 1915, 1986, 2030, 2042, 2070, 2080, 2104, 2169, 2178, 2375, 2385, 2448, 2463, 2486, 2511, 2760, 2798-2800, 2805, 3030, 3274, 3275, 3310, 3344, 3378, 3393, 3398, 3405, 3408, 3410, 3561, 3562, 3590, 3740, 3766, 3779, 3787, 3790, 3809, 3842, 3993, 3999, 4017, 4052, 4180, 4183
- Glypta murinanae* [*Cephaloglypta murinanae*] 4317
- Glypta* spp. 282, 406, 407, 464, 556, 573, 1314, 1655, 1869, 2366, 2398, 2439, 3310, 4156
- Gnathotrichus retusus* 2940
- Gnathotrichus sulcatus* 2940
- Goes pulverulentus* 2797
- Goes tigrinus* 2797
- Gomphaeshna furcillata* 3832
- Gomphus brevis* 3832
- Gomphus exilis* 3832

- Gomphus* spp. 3832
- Gonioctena americana* 1813, 1815
- Grammonota angusta* 1645
- Grammonota pictilis* 52, 2127
- Grapholitha molesta* 3466
- Gremmeniella abietina* 691, 3965
- Griselda radicana* 706, 712, 2282, 3046, 3606
- Habrocytus phycidis* 1125, 3779, 4017
- Hagenius brevistylus* 3832
- Halisidota* spp. 1155, 2057
- Harmologa fumiferana* [*Choristoneura fumiferana*] 525, 937, 974, 1642, 3667, 3671
- Harmologa fumiferana* [*Choristoneura occidentalis*] 1223, 1224, 1226, 1227, 1249, 1256
- Harmologa fumiferana* [*Choristoneura pinus*] 672, 1506
- Harmologa fumiferana* [*Choristoneura* spp.] 1436
- Heliothis armiger* 1974
- Heliothis zea* 1521, 1693, 1974
- Hemerocampa leucostigma* [*Orgyia leucostigma*] 2623
- Hemerocampa pseudotsugata* [*Orgyia pseudotsugata*] 194
- Hemichroa crocea* 2374
- Hemisturmia tortricis* 3779
- Hemiteles aercus* 4317
- Hemiteles albipalpus* 4317
- Heptagenia hebe* 1520
- Heptagenia* spp. 869
- Herpestomus hariolus* 316
- Hesperiphona vespertina* [*Coccothraustes vespertinus*] 463, 465, 2655, 2797, 4314
- Heterocampa guttivitta* 2797
- Heterorhabditis heliothidis* 1320, 1321, 2089
- Hippodamia convergens* 1640
- Hirsutella gigantea* 2089, 2223
- Hirsutella* spp. 2125, 2224, 2226, 2798
- Holomelina* spp. 4059
- Homona magnanima* 2956
- Horogenes cacoeciae* 1827, 2652
- Horogenes rosanae* 511
- Horogenes* spp. [*Casinaria* spp.] 511, 976, 4156
- Hyalella* spp. 1465
- Hyallela azteca* 1458
- Hyalophora cecropia* 3443
- Hylemya* spp. 3349
- Hylesia* spp. 2016
- Hylobius congener* 1744
- Hylobius pales* 921
- Hylobius radicis* 337
- Hylocichla ustulata* 2655
- Hylocichla ustulata swainsoni* 2567
- Hylocomium splendens* 258

- Hylurgops porosus* 1821
- Hypera brunneipennis* 824
- Hyphantria cunea* 836, 2631, 2797, 3460, 3796
- Hyposoter* spp. 1480
- Ichneumon pulcherior* 1722
- Ilex cornuta* 2797
- Ips calligraphus* 1821
- Ips oregonis* [*Ips pini*] 1233, 1234
- Ips perturbatus* 320
- Ips pini* 1507
- Ips sparsus* 317
- Ips typographus* 2035, 2691
- Ips* spp. 194, 921, 2893
- Iridoprocne bicolor* 1787
- Isaria* spp. 2224, 2798
- Ischnus inquisitorius artricollaris* 3779
- Ischnus minor* 3779
- Itoplectis atrocoxalis* [*Scambus atrocoxalis*] 316
- Itoplectis conquisitor* 53, 216, 334, 443, 511, 940, 957, 1073, 1074, 1118, 1125, 1589, 1590, 2030, 2104, 2375, 2798, 3398, 3779, 4017
- Itoplectis esuchus* [*Itoplectis quadricingulata*] 316
- Itoplectis evetriae* 3779
- Itoplectis maculator* 643, 4317
- Itoplectis obesus* [*Itoplectis quadricingulata*] 573, 714, 868
- Itoplectis quadricingulata* 1589, 1590, 1986, 3779, 3787, 3790, 3842
- Junco hyemalis* 888, 1956, 2655, 4314
- Junco* spp. 2797
- Juniperus scopulorum* 934
- Juniperus virginiana* 1821
- Juniperus* spp. 2935
- Kalmia angustifolia* 3734
- Kalmia latifolia* 888
- Kellymyia kellyi* 1738
- Lachnosterna* spp. 2057
- Lambdina fiscellaria* 2374, 2629, 3443, 3532
- Lambdina fiscellaria fiscellaria* 690, 1824, 2303, 2561, 2994, 3357, 3460, 3515, 3619, 3965
- Lambdina fiscellaria lugubrosa* 3360, 4178
- Lambdina somniaria* 2374
- Lambdina* spp. 1155
- Laphygma frugiperda* [*Spodoptera frugiperda*] 2016
- Larix decidua* 1744
- Larix laricina* 473, 896, 1557, 1744, 1841, 2056, 2093, 2247, 2345, 2682, 2691, 3000
- Larix leptolepis* 1744
- Larix occidentalis* 314, 370, 655, 702, 714, 1157, 1281, 1282, 1285, 1498, 1874, 2209, 2351, 2435-2438, 2440, 3291, 3293, 3294, 3296, 3297, 3347, 3349, 3357, 3835, 3840, 3848, 3948

- Larix* spp. 1650, 1859, 2031, 3506, 3674, 3684
Lasiomma anthracina 3780
Lasioseius spp. 3800
Laspeyresia pomonella 2797, 3466
Laspeyresia youngana 2374, 3780, 3831
Lecanium tiliae 2374
Ledum groenlandicum 2056
Leiobunum calcar 1853
Leptoglossus occidentalis 3346, 3349
Leptus spp. 1743, 1746, 3800
Lepus americanus 29, 3374
Leschenaultia americana 511
Lespesia frenchii 511
Lestes inequalis 3832
Leucania commoides 3800
Leucania pseudargyria 3800
Leucorrhinia frigida 3832
Leucorrhinia intacta 3832
Leuctra tenella 869
Leuctra spp. 869, 1165, 1180, 1556, 3819, 3821
Libellula exusta 3832
Libellula incesta 3832
Libellula lydia 3832
Linyphia phrygiana [*Pityohyphantes costatus*] 1859
Lissonota spp. 643, 1885
Lithobrancha recurvata 869
Loxia spp. 2797
Lozotaenia coniferana 3655
Lupinus polyphyllus 353
Lybellula quadrimaculata 3832
Lygaeonematus erichsoni 1504
Lymantria dispar 658, 921, 934-936, 981, 1518, 1889, 1979, 2035, 2081, 2523, 2557, 2797, 2798, 3083, 3330, 3833
Lymantria monacha 194, 2016, 2797
Lynx canadensis 29
Lyonetia saliciella 856
Lyophyrus abietis [*Adelges abietis*] 3661
Lypha setifacies 293, 531, 1074, 3779, 3809
Lypha spp. 976, 4156
Macremphytus spp. 3443
Macrocentrus iridescens 3779
Macrocentrus peroneae 3779
Macrocentrus spp. 3779
Madremyia saundersii 511, 714, 755, 832, 867, 868, 1559, 1986, 2385, 3275, 3779, 3787, 3790, 3842
Maianthemum canadense 1566, 3734
Malacosoma americanum 2016, 2062, 2064, 3443
Malacosoma californicum 3357
Malacosoma disstria 160, 194, 387, 650, 691, 1450, 1507, 1580, 1756, 1813, 1815, 1816,

- 2014, 2016, 2225, 2374, 2884, 3083, 3087,
3357, 3360, 3440, 3460, 3796, 4044, 4122,
4132, 4134, 4136, 4187
- Malacosoma pluviale* 4213, 4214
- Malacosoma* spp. 1155, 2797
- Manduca sexta* 2201, 3523
- Martes americana* 29
- Mastrus laplantei* 2315, 3779
- Medophron dytiscivorus* 2315
- Megaselia* spp. 3779
- Megastigmus spermotrophus* 1027, 3346, 3349
- Megastigmus* spp. 1030
- Melanerpes formicivorus* 2797
- Melanolophia imitata* 3357
- Melanophila* spp. 194
- Melolontha vulgaris* 71
- Melospiza lincolni* 4314
- Mesochorus diversicolor* [*Mesochorus*
tachypus] 1859
- Mesochorus sylvarum* 3779
- Mesochorus tachypus* 1590, 3787, 3790, 3842
- Mesochorus* spp. 511, 1590, 4180
- Mesoleius tenthredinis* 2691, 2797, 3661
- Mesopolobus milleri* 3779
- Mesopolobus verditer* 3779
- Mesopolobus* spp. 1590
- Metaphidippus flavipedes* 52, 1852
- Metarrhizium anisopliae* 3780
- Meteorus ruficeps* 1399, 3779
- Meteorus trachynotus* 293, 430, 443, 511, 957,
976, 1569, 1859, 2070, 2372, 2373, 2375, 2486,
2798, 2805, 3275, 3398, 3779, 3809, 3842,
3993, 3999, 4017
- Meteorus* spp. 406, 407, 464, 1885, 3310
- Microgaster canadensis* 3779
- Microgaster* spp. 2511
- Microsorex hoyi* 2655
- Microtendipes* spp. 869
- Microtus chrotorrhinus* 2655
- Microtus pennsylvanicus* 2655
- Mindarus abietinus* 2518, 3979
- Mniotilta varia* 590, 888
- Molothrus ater* 2324
- Monilinia laxa* 2797
- Monochamus scutellatus* 243, 317, 318, 2691,
3174
- Monochamus* spp. 1755
- Monodontomerus aereus* 643
- Monodontomerus areator* 4317
- Monodontomerus minor* 3779
- Mulsantina hudsonica* 3979
- Musca affinis* 3375
- Musca domestica* 1789
- Musca latifrons* 3375

- Musca ruralis* 3375
Muscina stabulans 3779
Mustela vison 1476, 3374
Mya arenaria 1325
Myrmica detritinodis 1855
Myzocallis alhambra 2064
Nadata gibbosa 3443
Napaeozapus insignis 2655
Nasonia tortricis 563, 1859
Nematocampa filamentaria 2282
Nematus erichsonii [*Pristiphora erichsonii*] 2691
Nemorilla floralis 867
Nemorilla floralis var. *maculosa* 940
Nemorilla pyste 511, 1655, 3310, 3779
Nemorilla spp. 1986
Nemoura spp. 1180
Neoaplectana carpocapsae 1892, 1893
Neoaplectana spp. 3301, 3901
Neodiprion abietis 1813, 1815, 2885, 3965
Neodiprion banksianae [*Neodiprion pratti banksianae*] 1507, 4136
Neodiprion burkei 487
Neodiprion lecontei 337, 338, 981, 1507, 1889
Neodiprion nanulus 4044
Neodiprion nanulus nanulus 1813, 1815
Neodiprion polytomum 1507
Neodiprion pratti banksianae 1889, 2730, 2991
Neodiprion sertifer 1889, 2016, 2374, 2885
Neodiprion swainei 690, 1755, 2325, 2418, 2991, 3443, 3458-3460
Neodiprion virginiana 1813, 1815
Neodiprion spp. 70, 1502, 1995, 2833
Neophasia menapia 767, 4178
Nephotettix cincticeps 824
Nepytia freemani 3357, 3360
Nepytia spp. 1155
Noctua pronuba 4277
Nosema cerasivoranae 3466, 3470, 4206
Nosema disstriae 3064, 4187
Nosema fumiferanae 612, 788, 905, 906, 1081, 1257, 1331, 1610, 1666, 1794, 2089, 2747, 2798, 3064, 4064, 4187, 4188, 4190-4194, 4196-4198, 4200-4205, 4207-4210, 4212-4214
Nosema whitei 4211
Nuttallornis borealis [*Contopus borealis*] 2655
Nygma phaeorrhoea 2374
Nymphalis antiopa 3443
Ocnerostoma strobivorum 700
Odocoileus hemionus [*Dama hemionus*] 350
Odocoileus virginiana [*Dama virginiana*] 29, 2925
Oligonychus ununguis 1273, 1278, 3868
Olor spp. 29

- Omalus* spp. 1422
- Omotoma fumiferanae* 486, 511, 714, 833, 867, 868, 976, 3779, 3809
- Omotoma* spp. 406, 407, 464, 4156
- Oncophanes americanus* 3779
- Oncorhynchus* spp. 2892
- Operophtera brumata* 690, 2374, 2797
- Ophiogomphus anomalus* 3832
- Ophiogomphus carolus* 3832
- Ophiogomphus rupinsulensis* 3832
- Ophiogomphus* spp. 3832
- Ophiostoma bicolor* 247
- Oporornis philadelphia* 888
- Orconectes virilis* 3420
- Orgilus lateralis* 3779
- Orgyia leucostigma* 2605, 3515, 3523
- Orgyia pseudotsugata* 608, 690, 921, 934-936, 1360, 1479, 1518, 1580, 1592, 1660, 1889, 1974, 1995, 2116, 2285, 2623, 2993, 3124, 3330, 3357, 3634, 3640, 3749, 4177, 4178
- Orthopoxvirus* spp. 379
- Orthosia hibisci* 1813, 1815
- Ostrinia nubilalis* 3443
- Othnius* spp. 1821
- Otopheidomenis zalelestes* 3800
- Paecilocyces farinosus* 2089
- Paleacrita vernata* 3443
- Paleodipteron walkeri* 1180
- Panolis flammea* 2797, 2956
- Paraleptophlebia* spp. 869, 2961
- Paralobesia viteana* 2956
- Paramecium caudatum* 1137
- Parania geniculata* 3779
- Parasyndemis histroinana* 2956
- Parula americana* 1817, 2655
- Parus ater* 2797
- Parus atricapillus* 1785, 1787, 2324, 2655, 2797
- Parus coeruleus* 2797
- Parus gambeli* 4314
- Parus hudsonicus* 1786, 1787, 2655, 2798
- Parus major* 2797
- Parus* spp. 2797
- Passaloecus ithacae* [*Passaloecus monilicornis* *ithacae*] 1422
- Passaloecus mandibularis* [*Passaloecus cuspidatus*] 1422
- Passer domesticus* 2797
- Passer montanus* 2797
- Passerculus sandwichensis* 888
- Passerina amoena* 4314
- Pediobius* spp. 2844
- Pedioecetes phasianellus* [*Tympanuchus phasianellus*] 29
- Peghylemyia anthracina* 3831

- Pemphredon* spp. 1422
- Perezia fumiferanae* [*Nosema fumiferanae*] 71, 2886, 3563, 3760, 3761, 3763-3765, 3767, 3768
- Perisoreus canadensis* 2655
- Peromyscus maniculatus* 2639, 2655
- Peromyscus maniculatus maniculatus* 597
- Peronea variana* [*Acleris variana*] 194
- Petrova* spp. 1507
- Phaeogenes cacoeciae* 47, 511
- Phaeogenes hariolus* [*Phaeogenes maculicornis hariolus*] 53, 209, 216, 486, 511, 714, 755, 784, 786, 787, 836, 867, 868, 925, 1074, 1125, 1480, 1559, 1589, 1590, 1986, 2030, 2375, 2383, 2798, 2799, 3310, 3809, 3842, 4017, 4180, 4183
- Phaeogenes maculicornis* 3275, 4317
- Phaeogenes maculicornis hariolus* 788, 3779, 3787, 3790
- Phaeogenes* spp. 406, 407, 464
- Phasgonophora* spp. 3821
- Phellinus weirii* 524
- Pheucticus ludovicianus* 888
- Philohela minor* [*Scolopax minor*] 4278
- Phobocampe* spp. 2370, 3310
- Phorocera erecta* 867
- Phorocera incrassata* 829, 836, 867, 3779, 3787, 3790, 4171
- Phorocera tortricis* 1074
- Phryxe pecosensis* 511, 755, 867, 868, 957, 976, 1074, 1118, 1986, 2328, 2805, 3310, 3398, 3779, 3999
- Phryxe vulgaris* 3779
- Phygadeuon plesius* 1859
- Phyllocnistis populiella* 3357
- Phyllophaga* spp. 337, 4222
- Phytodietus fumiferanae* 92, 178, 437, 556, 574, 714, 716, 834, 836, 867, 976, 1590, 2254, 2256-2259, 3165, 3274, 3275, 3329, 3779, 3792, 4156, 4171, 4172
- Phytodietus* spp. 2691, 3662
- Picea abies* 1744, 3255, 4159
- Picea canadensis* 3792
- Picea engelmannii* 2-4, 6, 7, 30, 236, 311, 314, 343, 344, 369, 370, 470, 714, 742, 755, 756, 890, 1498, 1874, 1960, 2040, 2042, 2076, 2098-2100, 2102, 2103, 2209, 2351, 2364, 2366, 2390, 2393, 2434-2440, 2511, 2898, 3158, 3160, 3162, 3166, 3349, 3357, 3365, 3625, 3835, 3840, 3848, 3948, 4013, 4166, 4167, 4170, 4175, 4176, 4181, 4182, 4184
- Picea glauca* 15, 19, 29, 46, 157, 159, 161, 203, 274, 292, 405, 422, 423, 429, 431-433, 438, 441, 447, 452, 453, 473, 477, 514, 516, 751, 775, 888, 892, 894, 896, 905, 979, 982, 987, 988, 1139-1142, 1144, 1315, 1322, 1346, 1361, 1362, 1365, 1366, 1380, 1392-1394, 1425, 1433, 1434, 1436, 1450, 1451, 1454, 1488, 1531, 1579, 1597, 1604, 1609, 1629, 1632, 1634, 1635, 1637, 1675, 1726, 1728-1730, 1744, 1756, 1770, 1816, 1828, 1841, 1890, 1901, 1942, 1951, 2000, 2052, 2056, 2122, 2135, 2146, 2209, 2212, 2215, 2220, 2230, 2312, 2327, 2334, 2335, 2345, 2401, 2402, 2408, 2449, 2497, 2509, 2538, 2590, 2599, 2600, 2607, 2609-2611, 2613, 2618, 2693, 2694, 2746, 2798, 2892, 2911, 2925, 2946,

- 2947, 2980, 3008, 3037, 3210, 3254, 3255,
3302, 3305, 3325, 3398, 3455, 3456, 3537,
3538, 3541, 3542, 3544, 3619, 3651, 3687,
3748, 3792, 3830, 3831, 3853, 3996, 3997,
4101, 4107, 4108, 4139, 4157, 4159, 4162,
4197, 4203, 4207, 4208, 4217, 4219, 4224,
4237, 4273, 4313
- Picea mariana* 15, 19, 29, 161, 274, 431, 433,
438, 453, 473, 514, 516, 739, 888, 894, 896,
1322, 1392-1394, 1425, 1454, 1488, 1531,
1579, 1597, 1667, 1744, 1756, 1776, 1828,
1841, 1879, 1942, 2052, 2056, 2057, 2209,
2210, 2212, 2215, 2220, 2278, 2327, 2345,
2420, 2509, 2514, 2558, 2694, 2798, 2989,
3000, 3001, 3146, 3147, 3308, 3325, 3506,
3537, 3538, 3541, 3542, 3544, 3612, 3619,
3792, 3997, 4101, 4157, 4217, 4219, 4237,
4311, 4317
- Picea pungens* 2-4, 6, 7, 755, 756, 890, 1677,
1841, 2042, 2076, 2099-2103, 2434, 2439,
3158, 3160, 3162, 3166, 3513, 3651, 4166, 4167
- Picea rubens* 15, 19, 46, 161, 431, 453, 473, 477,
514, 516, 551, 738, 739, 821, 888, 892, 896,
919, 969, 1142, 1322, 1392-1394, 1488, 1531,
1579, 1597, 1744, 1816, 1841, 1942, 2052,
2209, 2210, 2212, 2215, 2220, 2278, 2345,
2408, 2449, 2509, 2590, 2798, 2858, 2989,
3302, 3305, 3325, 3328, 3353, 3381, 3398,
3512, 3537, 3538, 3542, 3544, 3609, 3619,
3687, 3792, 3995, 4101, 4110, 4273, 4309
- Picea rubra* [*Picea rubens*] 1828
- Picea* spp. 244, 255, 265, 275, 285, 289, 367, 412,
417, 442, 651, 699, 701, 992, 1123, 1454, 1485,
1504, 1650, 1661, 1859, 1938, 2014, 2060,
2070, 2218, 2222, 2232, 2474, 2491, 2497,
2606, 2608, 2629, 2676, 2764, 2816, 3047,
3204, 3290, 3372, 3382, 3398, 3506, 3674,
3678, 3685, 3746, 3990, 4023, 4215, 4308
- Picoides albolarvatus* 2797
- Picoides arcticus* 2655
- Picoides major* 2797
- Picoides pubescens* 2797
- Picoides tridactylus* 29, 2797
- Picoides villosus* 2797
- Pieris brassicae* 3443
- Pikonema alaskensis* 2345, 3443
- Pimpla conquisitor* [*Itoplectis conquisitor*] 976,
1859
- Pimpla ontario* [*Ephialtes ontario*] 1859
- Pimpla tenuicornis* 3779
- Pimpla turionellae* 1738, 4317
- Pineus piceacorticalis* 3031
- Pineus pinifoliae* 3031
- Pineus strobi* 194, 2374
- Pinicola enucleator* 2655
- Pinus banksiana* 52, 53, 279, 283, 322, 325, 332,
422, 697, 772, 773, 995, 1125, 1348, 1349,
1384, 1436, 1502, 1744, 1755, 1821, 1825,
1835, 1837, 1838, 2032, 2033, 2056, 2057,
2068, 2154, 2324, 2498, 2500, 2759, 2858,
2931, 3122, 3178, 3192, 3255, 3506, 3619,
4017, 4091, 4161
- Pinus contorta* 370, 606, 1108, 2351, 2368, 2435-
2438, 2440, 2682, 2914, 2931, 3539
- Pinus contorta* var. *latifolia* 700, 2365, 2369
- Pinus contorta* var. *murrayana* 3571
- Pinus divaricata* [*Pinus banksiana*] 4251
- Pinus edulis* 3677
- Pinus flexilis* 3602
- Pinus glauca* 1674

- Pinus lambertiana* 2932, 3122
- Pinus ponderosa* 370, 606, 704, 705, 714, 934, 1157, 1281, 1821, 2040, 2042, 2293, 2365, 2434-2440, 2797, 3162, 3539, 3571, 3602, 3676-3679, 3685, 4166, 4167, 4170, 4175
- Pinus ponderosa* var. *ponderosa* 3205
- Pinus resinosa* 264, 422, 995, 1744, 2031, 2033, 2056, 2323, 2498, 2500, 2763, 3122, 4091
- Pinus strobus* 473, 1394, 1452, 1744, 1841, 2056, 2345, 2518, 2763, 3255, 3619, 3674, 4091, 4309
- Pinus sylvestris* 4091, 4279
- Pinus* spp. 992, 1485, 1650, 2031, 3684, 3853
- Piranga ludoviciana* 4314
- Pissodes approximatus* 2797
- Pissodes dubius* 176, 3665
- Pissodes piniphilus* 2797
- Pissodes strobi* 194, 337, 556, 856, 921, 981, 1507, 2374, 3083
- Pityokteines sparsus* 243, 318, 3665, 3667, 3671
- Platypus wilsoni* 2940
- Platynus decentis* 1132, 3032
- Pleistophora schubergi* 1794, 3064, 4187, 4189, 4193, 4195, 4197, 4208
- Pleistophora* spp. 612, 2885, 3466, 3470, 4199, 4206
- Plethodon cinereus* 1064
- Plusia chalcites* 1131
- Plutella maculipennis* 3443
- Podisus serieventris* 52, 1889
- Podosesia syringae* 2797
- Poemenia* spp. 1422
- Polioptila caerulea* 1817
- Polycentropus* spp. 869
- Polygraphus rufipennis* 1776, 2025, 3423, 3667
- Polyporus abietinus* 243, 245, 247-249, 3620
- Polyporus schweinitzii* 1393, 2056
- Popillia japonica* 71
- Populus tremuloides* 29, 1756, 1781, 2014, 2056, 2345, 3122, 3162, 3357, 3456
- Populus* spp. 888, 1661, 2134, 3796, 4134
- Porthetria dispar* [*Lymantria dispar*] 1817, 2016, 2623
- Pristiphora albietina* 2797
- Pristiphora erichsonii* 1507, 1813, 1815, 2225, 2374, 2682, 2730, 2797, 2885, 3357, 3443
- Pristiphora geniculata* 2374, 3031
- Proctolaelapa* spp. 3800
- Prodenia litura* 2016
- Pronematus pyrrhippeus* 3800
- Prosopium williamsoni* 827
- Protobarmia porcelaria* 3443
- Prunus pensylvanica* 29, 2345, 3997
- Pseudaletia separata* 3800
- Pseudaletia unipuncta* 3800
- Pseudexentera oregonana* 1813, 1815
- Pseudolimnophila* spp. 869

- Pseudomonas aeruginosa* 72
- Pseudoperichaeta erecta* 511, 3779
- Pseudoperichaeta* spp. 1986
- Pseudoplusia includens* 1974, 2844
- Pseudosarcophaga affinis* [*Agria housei*] 511, 792, 1735-1740, 4171
- Pseudosarcophaga* spp. 3375
- Pseudotsuga menziesii* 2-7, 32-34, 171, 227, 236, 292, 311, 343, 344, 369, 370, 517, 518, 523, 562, 602, 632, 655, 704, 709, 710, 712, 717, 718, 742, 746, 747, 756, 759, 857, 890, 933, 934, 1086, 1088, 1108, 1157, 1270, 1498, 1563, 1583, 1589-1592, 1641, 1700, 1711, 1903, 1960, 2042, 2046, 2076, 2085-2087, 2096, 2098-2103, 2116, 2209, 2269, 2274, 2284, 2293, 2351, 2353, 2364, 2366, 2380-2382, 2386, 2387, 2390, 2391, 2393, 2434-2440, 2696, 2722, 2839, 2841, 2898, 2912, 3007, 3010, 3017, 3100, 3122, 3158, 3160, 3180, 3275-3279, 3290, 3344, 3346, 3347, 3349, 3357, 3371, 3389, 3390, 3513, 3587-3589, 3622, 3623, 3625, 3676-3679, 3685, 3697, 3757-3759, 3787, 3904, 3970, 3971, 4004, 4005, 4007, 4033, 4175-4177, 4181, 4182, 4184
- Pseudotsuga menziesii* var. *glauca* 13, 313, 314, 470, 656, 657, 666, 701, 702, 705, 755, 760, 966, 1273, 1278, 1281, 1475, 1861, 1874, 2040, 2354, 2355, 2357, 2922, 3014-3016, 3162, 3166, 3205, 3323, 3348, 3539, 3551, 3706, 3711-3714, 3718, 3835, 3840, 3848, 3948, 4013, 4166, 4167, 4170, 4283
- Pseudotsuga taxifolia* [*Pseudotsuga menziesii*] 714, 836, 2511
- Pseutosuga menziesii* var. *menziesii* 2357
- Psychophagus omnivorus* 3779
- Psychophagus tortricis* 2798, 3779
- Psychophagus* spp. 3779
- Pterocormus gestuosus* 3779
- Pterostichus adoxus* 3032
- Pterostichus pensylvanicus* 3032
- Pterostichus rostratus* 3032
- Pterostichus tristis* 3032
- Ptycholmoides aeriferana* 1885
- Ptychopoda seriata* 2016
- Pucciniastrum epilobii* 856
- Pullularia pullulans* 2538
- Pungitius pungitius* 870
- Puto* spp. 3534
- Pychnopsyche* spp. 869
- Pygostolus sticticus* 2314
- Pyrausta nubilalis* [*Ostrinia nubilalis*] 4235
- Pyrrhalta luteola* 1892
- Quercus rubra* 1889, 2557
- Quercus* spp. 3561
- Rachiplusia ou* 1974
- Rangifer tarandus* 29
- Raphia frater* 4059
- Recurvaria milleri* [*Coleotechnites milleri*] 2016
- Regulus calendula* 584, 590, 1956, 2396, 2655
- Regulus regulus* 2797
- Regulus satrapa* 888, 2655
- Rhabdocline pseudotsugae* 1870

- Rhyacionia buoliana* 194, 929, 934, 935, 1507, 2062, 2064, 2374
- Rhyacionia frustrana* 1507, 4044
- Rhyacionia zozana* 929
- Rogas* spp. 511
- Roptrocercus xylophagorum* 2797
- Rubus idaeus* 2345, 2925
- Rygchium leucomelas* [*Euodynerus leucomelas*] 1422
- Salmo clarki* 1471
- Salmo gairdneri* 827, 1216
- Salmo salar* 1793, 2014, 2199, 2200, 2883, 2960
- Salmo trutta* 827
- Salvelinus fontinalis* 589, 1043, 1165, 1489, 1791, 1952, 1953, 2015, 2200, 2960
- Salvelinus malma* 1471
- Salvelinus namaycush* 1952
- Saperda calcarata* 2797
- Saperda carcharias* 2797
- Sarcophaga aldrichi* 160, 1087, 3563
- Sarcophaga cooleyi* 3779
- Sarcophaga hinei* 1087
- Sarcophaga houghi* 1087
- Scambus buolianae* 2062-2064
- Scambus decorus* 3779
- Scambus hispae* 3310, 3779
- Scambus hispae* [*Ephialtes hispae*] 4017
- Schistocerca gregaria* 3333
- Schizura semirufescens* 4059
- Sciaphila duplex* 1813, 1815
- Sciurus hudsonicus* [*Tamiasciurus hudsonicus*] 2056
- Sclerotinia cinerea* 2797
- Scolytus subscaber* 1233, 1234
- Scolytus ventralis* 286, 921, 1580, 2116, 2893
- Scolytus* spp. 2890
- Seiurus aurocapillus* 888, 1956, 2655, 2797, 4312
- Semiothisa bicolorata* 1813, 1815
- Semiothisa sexmaculata* 1813, 1815
- Semotilus atromaculatus* 1043
- Serratia marcescens* 72
- Setophaga ruticilla* 622, 623, 888, 2655
- Sialis* spp. 1952
- Simulium venustum* 1180
- Simulium* spp. 869, 2960
- Sirex juvencus* 3619
- Sirex* spp. 243
- Sitotroga cerealella* 728, 1741, 1744, 1751, 2051, 2825, 3535
- Sitta canadensis* 2655
- Sitta carolinensis* 2655
- Smerinthus germinatus* 2201
- Solanum* spp. 351

Somatochlora albicincta 3832
Somatochlora elongata 3832
Somatochlora forcipata 3832
Somatochlora kennedyi 3832
Somatochlora minor 3832
Somatochlora spp. 3832
Sorbus americana 258
Sorex cinereus 2655
Sorex cinereus cinereus 597
Sphagnum spp. 2056
Sphinx convolvuli 2201
Sphyrapicus varius 888, 2655, 4314
Sphyrapicus varius varius 3197
Spilochalcis albifrons 3310
Spinus pinus [*Carduelis pinus*] 4314
Spizella passerina 2279, 2324, 2797, 3418, 3442, 4314
Spodoptera frugiperda 1974, 2956
Spodoptera littoralis 1479
Stereum chailletii 243, 245, 247, 248, 3619, 3620
Stereum sanguinolentum 1393, 2056, 2719, 3620
Sternonema fuscum 1520
Stictopisthus flaviceps 3779
Stilpnolia salicis 2374
Sturmia spp. 3779
Sturnus cineraceus 2797
Symmorphus cristatus cristatus 1422
Sympetrum spp. 3832
Symphoricarpos albus 1327
Symphoricarpos oreophilus 2769
Synaptomys borealis 2655
Synaptomys cooperi 2655
Synetaeris tenuifemur 976, 2486, 2487, 3779, 4019
Synetaeris spp. 3993
Syngrapha angulidens 3606
Syntomosphyrum esurus 1125, 3779
Syspasis tauma 3779
Tachinomyia nigricans 3779
Tamiasciurus hudsonicus 1124, 2639, 2656
Taxus brevifolia 2351
Telenomus californicus 1480
Temelucha spp. 3842
Tetragoneuria canis 3832
Tetragoneuria cynosura 3832
Tetragoneuria spinigera 3832
Tetrastichus tibialis 2093
Thelohania spp. 612, 4199, 4206
Thelonia spp. 1590
Theridion differens 1859
Theridion murarium 52

- Theridion spirale* 1859
- Theronia atalantae fulvescens* 2370, 3779
- Thuja occidentalis* 1394, 2056, 2345, 2763, 2925, 3853, 3997
- Thuja plicata* 2351
- Thymelicus lineola* 3460
- Timavia fumiferanae* 3787, 3790
- Tortrix diversana* 1405
- Tortrix fumiferana* [*Choristoneura fumiferana*] 107, 401, 522, 527, 563, 753, 793, 1466, 1470, 1499, 1504, 1682, 1858-1860, 2691, 2817, 3165, 3193, 3656, 3664, 3796
- Tortrix fumiferana* [*Choristoneura occidentalis*] 1682
- Tortrix fumiferana* [*Choristoneura* spp.] 2352
- Tortrix nigrida* [*Choristoneura fumiferana*] 928
- Tortrix rusticana* 1405
- Tranosema arenicola* [*Tranosema rostrale rostrale*] 4018
- Tranosema rostrale* 3779
- Tranosema taeniopus* 4018
- Trichiocampus irregularis* 3443, 3466
- Trichiocampus viminalis* 3443
- Trichoderma viride* 243
- Trichogramma minutum* 62, 132, 316, 714, 728, 755, 867, 868, 899, 976, 1073, 1074, 1118, 1349, 1589, 1590, 1741-1745, 1747, 1751, 1752, 1850, 1882, 1910, 1916, 1961, 2040, 2042, 2051, 2070, 2093, 2421, 2434, 2439, 2455, 2489, 2613, 2716, 2798, 2800, 2825, 3535, 3711, 3747, 3779, 3787, 3790, 4166, 4170
- Trichogramma* spp. 784, 3728, 3999
- Trichoplusia ni* 1693, 1974, 2201, 2844, 3556, 3566
- Triclistus alobulipes* 4317
- Triclistus podagricus* 2093
- Troglodytes troglodytes* 888, 2655
- Trypodendron cavifrons* [*Trypodendron lineatum*] 2940
- Tsuga canadensis* 473, 514, 1361, 1394, 1841, 2509, 3398, 3537, 3538
- Tsuga heterophylla* 3357, 3840
- Tsuga mertensiana* 3840
- Turdus merula* 2797
- Turdus migratorius* 888, 1063, 1988, 2655, 2797, 2798, 4314
- Tussilago farfara* 354
- Urocerus albicornis* 3619
- Urocerus gigas* 3619
- Vaccinium* spp. 3255
- Venturia populina* 856
- Vermivora peregrina* 622-624, 888, 1956, 2396, 2655
- Verticicladiella wagneri* 921
- Vespula norwegica norvegicoides* 3443
- Vespula rufa consobrina* 3443
- Viburnum cassinoides* 1566, 2443
- Viburnum trilobum* 3734
- Vireo gilvus* 4314

<i>Vireo olivaceus</i>	888	<i>Zeiraphera canadensis</i>	3515, 3517
<i>Vireo ruficapillus</i>	888	<i>Zeiraphera diniana</i>	2512
<i>Vireo solitarius</i>	888, 2655	<i>Zeiraphera fortunana</i>	3046
<i>Williamsonia fletcheri</i>	3832	<i>Zeiraphera hesperiana</i>	706, 712, 2282, 3606
<i>Wilsonia canadensis</i>	888	<i>Zeiraphera improbana</i>	2093
<i>Winthemia fumiferanae</i>	1090, 1589, 1590, 1859	<i>Zeiraphera ratzeburgiana</i>	2512, 3046
<i>Winthemia</i> spp.	3779	<i>Zeiraphera rufimitrana</i>	2512
<i>Xanthophyto</i> spp.	3779	<i>Zeiraphera truncata</i>	3655
<i>Xeris spectrum</i>	3619	<i>Zelleria haimbachi</i>	700
<i>Xiphenima bakeri</i>	1257	<i>Zelus socius</i>	1655
<i>Xyleborinus tsugae</i>	2940	<i>Zenillia caesar</i>	209, 1125
<i>Xysticus</i> spp.	1422	<i>Zenillia pecosensis</i>	1125
<i>Ypsolophus nella</i>	3606	<i>Zonotrichia albicollis</i>	622, 624, 625, 888, 1956, 2655, 2798
<i>Zale duplicata largera</i>	1813, 1815	<i>Zoophthora radicans</i>	788, 1081
<i>Zale</i> spp.	3800		

AUTHOR INDEX

- Abrahamson, L. P. 1, 44-46, 48, 49, 3146, 3147
- Acciavatti, R. E. 2-7, 2839-2841
- Action Sociale Ltee. 4037
- Adams, W. 857
- Adamski, D. 8
- Adamus, P. R. 9, 10, 1792
- Addy, N. D. 11, 12, 279, 1839, 2325
- Aho, P. E. 13
- Aizawa, K. 14
- Akers, R. P. 4009
- Akesson, N. B. 2081
- Albers, M. A. 719
- Albert, P. J. 15-24, 161
- Aldrich, J. W. 3611, 3612
- Aldrich, R. C. 25, 1658
- Alexander, C. E. 26-28
- Alexander, K. G. 2906
- Alexander, M. E. 29
- Alexander, R. R. 30
- Alfaro, R. I. 31-34, 1586, 3755, 3971
- Alford, A. R. 35-40, 3385
- Allan, D. R. 41
- Allen, D. C. 1, 42-53, 1349, 1350, 2326, 3147, 3305
- Allen, S. J. 54-59
- Allison, R. A. 769
- Almas, D. 2117
- Alverson, L. 1665
- Anderson, C. B. 60
- Anderson, G. W. 61
- Anderson, J. F. 62, 1891, 1978, 4123
- Anderson, M. 4172
- Andrews, R. J. 63-66
- Andrews, T. L. 67, 2524, 2525
- Angerilli, N. 68
- Angus, T. A. 69-74, 1652, 1653, 2606, 2680, 2794, 4290
- Annand, P. N. 75-77
- Anon. 78-130
- Applejohn, M. J. 131-137, 1757, 1772, 1773, 4111
- Archambault, L. 138, 453
- Arehart-Treichel, J. 139
- Arif, B. M. 140-146, 377, 379, 901, 903, 915, 3064, 3963
- Armson, K. A. 147
- Armstrong, J. A. 148-159, 2607-2613, 2615
- Arn, H. 2956
- Arner, S. L. 3322
- Arno, S. F. 1551
- Aronson, D. G. 2131
- Arthur, A. P. 160
- Arthurs, C. A. 2578, 2579

- Ascoli, A. 161
- Ashley, M. D. 162-167, 2583
- Atkinson, C. C. 210
- Atkinson, G. 1438
- Atterbury, T. 3527
- Atwood, C. E. 168-170
- Auger, M. 46, 455
- Averill, R. D. 171, 1862, 3100
- Avery, A. C. 172, 173
- Ayer, D. K. 3031
- Back, R. C. 174
- Baggly, G. F. 175
- Bailey, I. W. 176, 177
- Bailey, W. F. 1480, 4168
- Baird, A. B. 178
- Baird, D. 3517
- Baker, B. H. 179, 180
- Baker, H. 181
- Baker, R. 936
- Baker, W. L. 182
- Bakuzis, E. V. 96
- Balch, R. E. 183-213
- Baltensweiler, W. 777, 2973, 3232, 3361
- Banash, S. E. 323, 327, 333, 339, 3012
- Banaugh, R. P. 214
- Banfield, E. C. 781-787
- Banks, D. 1556
- Barcia, D. R. 215
- Barker, R. B. 216, 217
- Barlow, J. S. 1739
- Barltrop, E. M. 504
- Barnes, B. V. 1698
- Barnes, C. A. 218, 1221, 3770
- Barnes, D. P. 219-222, 3428-3430
- Barras, S. J. 281, 1979, 4246
- Barrett, F. M. 223
- Barrett, L. J. 3007, 3015
- Barringer, R. E. 224
- Barrows, M. 225
- Barry, J. W. 226-241, 1182, 1183, 1327, 3316, 4295
- Barry, R. W. 3143
- Bart, J. 242
- Bartell, R. J. 3247
- Basham, J. T. 243-249, 2999
- Baskerville, G. L. 250-263, 898, 1713, 1970, 1971
- Bassett, J. R. 264, 1337
- Batzer, H. O. 265-285, 291, 292, 1843, 2285, 2507, 2508, 3204, 3749
- Baudreau, G. S. 3164
- Bauer, L. S. 2122, 2123

- Baumgartner, D. M. 760, 1284, 1475, 1707, 2116, 2152, 2296, 3645, 3859
- Beal, J. A. 286, 287, 1147, 1148
- Bean, J. L. 268, 269, 288-306, 548, 550, 1070, 1465, 1659, 2156, 2346, 4039, 4091, 4223, 4224
- Beanlands, G. E. 307
- Beaubien, J. 308
- Beaulieu, J. 309
- Beck, A. B. 353
- Beck, W. R. 310
- Beckman, D. 1473, 1823, 2112-2114, 2117-2119, 3312
- Beckwith, R. C. 311-315, 654, 657, 661, 1843, 3550, 3551, 3790
- Bedard, W. D. 316
- Beddows, D. 1522
- Beique, R. 347
- Beirne, B. P. 1090
- Bell, J. F. 3527
- Bell, R. K. 1555
- Belyea, G. Y. 1063
- Belyea, R. M. 249, 317-320, 4134
- Benedict, W. V. 321
- Benjamin, D. M. 322-339, 772, 773, 1074-1077, 1125, 3352
- Bennett, C. W. 340-342, 635, 2467, 2662
- Bennett, D. D. 343-345, 3160
- Bennett, G. F. 1320, 1321
- Bennett, R. B. 2392
- Benoit, P. 346-349, 454, 1347, 2305, 2306
- Benson, W. W. 350
- Bentley, M. D. 39, 351-355
- Benyus, J. M. 356
- Benzie, J. W. 357, 358, 477
- Bergelin, L. A. 2772
- Berger, S. 1552
- Bergh, J. C. 359
- Bergh, R. M. 891
- Bergold, G. H. 360-362, 2016, 2017
- Berkett, L. P. 1746
- Berndt, M. 3011
- Beroza, M. 1798, 2035
- Berry, D. W. 528, 577
- Berryman, A. A. 363, 364, 934, 3307, 3638
- Bertwell, R. L. 365
- Besley, F. W. 366
- Bess, H. A. 367, 368
- Bestmann, H. J. 611
- Bevan, D. 4054
- Beveridge, R. L. 369-371, 1986, 2293
- Beveridge, W. J. G. 155
- Bible, T. A. 372
- Bickerstaff, A. 373

- Bicknell, A. T. 374
- Bider, J. R. 507
- Bigalow, G. C. 2901
- Biggs, W. D. 375, 376
- Bilimoria, S. L. 377-379
- Binotto, A. P. 380-382
- Birch, M. C. 383
- Bird, F. T. 384-396, 902, 1770, 3085, 3560, 3561
- Bishop, R. L. 2654
- Bissell, L. P. 397-399
- Bjorkbom, J. C. 1393
- Bjorklund, J. R. 1129, 1130
- Bjornn, T. C. 844
- Black, W. F. 2068, 2069
- Blackman, M. W. 400, 401
- Blackmer, F. H. 402
- Blackmer, S. D. 3195
- Blais, J. R. 403-469, 985, 2373, 2401, 2468, 2917, 3175, 4092
- Blake, E. A. 470, 4013
- Blake, G. M. 759
- Blanchard, R. O. 471
- Blaskovic, D. 3521
- Blease, J. A. 1043, 1063-1065
- Blomquist, C. R. 472
- Blum, B. M. 473-480, 1394, 1455
- Blumenstock, M. W. 481
- Bobal, K. A. 1019
- Boegler, J. A. 3316
- Boelter, L. M. 3120
- Bogenschutz, H. 482, 2956
- Bollen, W. B. 483
- Bongberg, J. W. 484, 485
- Bonneau, G. 486
- Bonnicksen, T. M. 1712
- Bontemps, X. 2904
- Borden, J. H. 487, 3571
- Borg, T. K. 3602
- Borland, S. A. 3745
- Boucias, D. G. 488, 2231
- Boudoux, M. 3960
- Bourassa, G. H. 167, 489
- Bourque, P. M. 490
- Bouse, L. F. 3500
- Bousfield, W. E. 371, 491-502, 700, 765, 770, 1997, 2362, 3312, 3843
- Bowyer, J. L. 503, 1491, 3425
- Boyer, M. G. 504
- Boynton, J. C. 505
- Brace, L. G. 506
- Bracher, G. A. 507
- Bradbury, R. L. 2788

- Bradshaw, D. B. 2999, 3965
- Braid, P. E. 508, 509
- Bramhall, A. E. 1637
- Brandt, N. R. 510, 511
- Brann, T. B. 512-516, 1676, 1746, 3273, 3530
- Brewer, J. W. 517, 518, 2285, 3603, 3604
- Bricault, F. A. 519, 520
- Brickell, J. E. 4033
- Bridgwater, D. R. 521
- Briggs, R. D. 919
- Briscoe, J. M. 522
- British Columbia Forest Service 523
- British Columbia Ministry of Forests 524
- Britton, W. E. 525-527
- Brockman, C. F. 528
- Brockway, B. 167
- Brodersen, H. 529, 530, 1222
- Brookes, M. H. 3857
- Brooks, A. R. 531
- Brooks, M. A. 1705
- Brower, A. E. 532, 533
- Brown, A. W. A. 534-543, 974, 1520
- Brown, C. E. 544-546
- Brown, D. 547
- Brown, G. 1755
- Brown, H. L. 10, 305, 548-550, 3408
- Brown, K. M. 1322
- Brown, K. W. 140, 144
- Brown, M. W. 551, 552
- Brown, N. R. 553-555, 738, 3609
- Brown, R. C. 556-560
- Brown, R. G. 561, 1586, 1591, 2584
- Brown, S. J. 2150
- Brubaker, L. B. 562
- Brues, C. T. 563
- Brun, G. L. 2853
- Brushwein, J. R. 564-568, 1516
- Bryant, D. G. 569
- Bryer, J. B. 843
- Buchanan, W. D. 570-574, 1122
- Bucher, G. E. 575
- Buchheim, M. P. 576
- Buckhorn, W. J. 577, 1414, 2095, 4055
- Buckner, C. H. 156, 578-600, 1301, 1302, 2745, 2952
- Buffam, P. E. 601-605
- Buhyoff, G. J. 606, 607, 4146
- Bullard, A. T. 608, 609
- Burges, H. D. 610, 2300, 3500, 4190
- Burgess, J. 3516, 3517
- Burghardt, G. 611

- Burke, J. M. 395, 612-617, 903, 1609, 2885, 4206
- Burke, R. E. 618, 619
- Burlock, C. L. 2571, 2572
- Burnell, D. G. 315
- Burns, B. S. 3692
- Burns, R. M. 30, 358, 477, 1498, 1879, 3166, 3192, 3205, 3296, 3323
- Burrier, T. 620
- Burry, W. L. 621
- Burton, E. 2692
- Busby, D. G. 622-625
- Bushway, R. J. 351
- Butler, J. M. 626
- Butler, W. S. 627
- Cadogan, B. L. 628, 629
- Cahill, D. B. 370, 630-633, 2293, 2294, 2387, 3016, 4029
- Caltrell, R. M. 2851, 2900-2902, 3141, 3142
- Calvert, R. F. 634
- Calvert, W. C. 258
- Cameron, D. G. 635, 2193, 2194, 4093, 4094, 4097-4099
- Cameron, J. W. M. 636-640, 4133
- Cameron, L. 641, 642
- Cameron, M. D. 163, 515, 643, 644, 1167-1170, 1290, 2059, 2146, 2216, 2217, 2717, 2910, 2994, 3380, 3528, 3750, 4243
- Cameron, T. 3516-3518
- Campbell, A. E. 2900
- Campbell, G. A. 4140
- Campbell, G. S. 645
- Campbell, I. M. 646-650
- Campbell, J. 719
- Campbell, L. M. 651, 986-989
- Campbell, R. A. 725
- Campbell, R. K. 3282
- Campbell, R. W. 652-666, 702, 3550, 3551, 3789, 3790, 4300
- Canada Department of Agriculture 669-673
- Canada Department of Agriculture, Forest Biology Laboratory 667
- Canada Department of Agriculture, Forest Insect Investigations 959
- Canada Department of Agriculture, Science Service, Forest Biology Division 668
- Canada Department of Forestry and Rural Development 674
- Canada Department of Regional Economic Expansion 675
- Canada Department of the Environment 676
- Canada/United States Spruce Budworms Program 677-680
- Canadian Forestry Service 88, 681-696
- Canavera, D. S. 697
- Cancela da Fonseca, J. P. 698
- Capek, M. 699
- Capinera, J. L. 517

- Carde, R. T. 2975-2977
- Carew, G. C. 784-791
- Carlson, C. E. 495, 498, 655, 700-705, 1284, 1286, 3145, 3295, 4282
- Carolin, V. M. 604, 706-718, 1118, 1122-1124, 1415, 3605, 3606, 3854, 3858, 4154
- Carroll, M. R. 719
- Carroll, W. J. 720, 721, 1356, 3031
- Carrow, J. R. 101, 147, 250, 634, 722-728, 1376, 1477, 1478, 1527, 1761, 1762, 2061, 2422, 2423, 2725, 2786, 2830, 3144, 3234, 3434, 3607, 3786, 3964, 4138
- Carter, C. E. 3990
- Carter, K. K. 729, 730
- Carter, N. E. 731-740, 2990
- Cartier, J. P. 741
- Case, A. B. 626, 2999
- Casebeer, R. L. 742, 844
- Casida, J. E. 2526
- Casti, J. 743
- Castrovillo, P. J. 744, 3632
- Cates, R. G. 745-747, 3017
- Cayford, J. H. 748, 749
- Cearley, C. 17
- Cerezke, H. F. 750, 751, 1695, 1696, 2562, 2563, 3249
- Chabot, M. 752
- Chambers, E. L. 753, 754
- Chansler, J. F. 755-757, 2387
- Chapman, D. W. 1471
- Chapman, R. C. 3689
- Charlebois, N. 1206, 1207
- Chase, A. 499
- Chavez, J. M. 3161
- Chen, C. W. 3393-3395, 3398, 3409, 3410
- Cherry, J. 1792
- Cheshire, W. F. 2655, 2656
- Chiang, H. C. 3357, 4222
- Childerhose, R. J. 758
- Chow, T. L. 3105
- Chrisman, A. B. 759
- Christensen, C. M. 1701-1703
- Christensen, N. L. 1712
- Christophersen, A. 760
- Church, T. W., Jr. 761
- Churcher, J. 762
- Ciesla, W. M. 227, 233, 234, 239-241, 763-771, 1025, 1327, 1984, 2114, 2295, 3316
- Clancy, K. M. 772, 773
- Clark, J. 774, 775
- Clark, R. C. 569
- Clark, W. C. 776-778, 1713, 1714, 2892
- Clarke, F. R. 1322
- Clarke, J. M. 779

- Clarke, L. J. 780-791, 2997-2999, 4026
- Clausen, C. P. 792
- Clemens, B. 793
- Clifford, R. E. 794
- Cloutier, M. 2828
- Clovis, C. J. 2747
- Coady, L. J. 795-799, 2571-2580
- Coady, L. W. 800
- Cochrane, R. H. 964
- Cochrane, W. P. 801
- Cokendolpher, J. C. 1853
- Colbert, J. J. 802, 1907
- Colby, F. H. 401
- Cole, A. F. W. 4307
- Cole, W. E. 803-815, 4030
- Collins, J. A. 816
- Collins, W. J. 3039
- Collis, D. G. 817, 3182
- Comeau, A. 818, 4065
- Comite de Coordination des Recherches sur
l'Economique de la Tordeuse 819
- Commonwealth Institute of Entomology 820
- Compton, L. M. 4156
- Conkey, L. E. 821
- Conkle, M. T. 3639
- Conner, J. Y. 3811
- Conner, R. N. 1817, 1818, 2797
- Connor, J. Y. 822, 1016, 3812
- Conover, G. 1126
- Constable, D. C. 823, 3206, 4112-4117
- Conway, G. R. 824
- Cook, J. A. 825, 826, 2682
- Cope, J. B. 1667
- Cope, O. B. 827, 828
- Copeman, A. G. 989, 995
- Coppel, H. C. 160, 829-837, 2012, 2328, 2374,
4173
- Corbet, P. S. 838
- Corcoran, D. J. 164, 839
- Corcoran, T. J. 380, 382, 644, 840-843, 895, 916,
1071, 1154, 1397, 1445, 1449, 1562, 1636,
1795, 1894, 1902, 1976, 2726, 2903, 3022,
3273, 3303, 3382, 3400, 3431, 4024, 4288
- Corley, D. R. 844
- Cormier, J. R. 845, 846
- Cornelius, R. O. 847
- Corrivault, G. W. 2829
- Corriveau, A. 848
- Cory, H. T. 849, 931
- Coster, J. E. 281, 850, 1973, 1979, 4246
- Cottrell, C. B. 851-857, 2585
- Coughlin, J. 858-865
- Coulter, W. K. 708-712, 866-868

- Courtemanch, D. L. 869-872, 1458-1463
- Cox, C. E. 873
- Crabbe, R. 874-876
- Craig, M. B. 1944, 2194
- Craighead, F. C. 877-882, 3673
- Crawford, H. S. 883-889, 1840, 1841, 2048
- Creasap, V. L. M. 890
- Cree, K. L. 3823
- Crisp, C. E. 3100
- Crocker, J. F. 891
- Croghan, C. F. 3196
- Crook, G. W. 892
- Crookston, N. L. 802, 893, 1907
- Croome, G. C. R. 894
- Crosby, D. 2156
- Crowell, J. B. 895
- Crummey, H. R. 896
- Cuff, W. 897, 898, 3411
- Cuming, F. G. 1356
- Cunningham, J. C. 156, 393, 600, 899-915, 1700, 1770, 1890, 2613, 3330, 3368, 3963
- Cyr, M. 916
- Czapowskyj, M. M. 917-919, 2556, 3146, 3147, 3305
- Czerwinski, E. J. 3771, 3772
- Dahlsten, D. L. 920, 921
- Dale, J. W. 922-924
- Dalleske, R. L. 925
- Dang, P. T. 926
- Daniel, T. C. 606, 607, 927, 4146
- Dantzig, G. B. 1713
- Darlington, E. P. 928
- Darvesh, S. 3183, 3285, 3289
- Daterman, G. E. 849, 929-936, 3248, 3249, 3266, 3267, 3539
- Daves, G. D., Jr. 849, 931
- Daviault, L. 937-962, 2402
- Davidek, B. 2114
- Davidson, A. G. 963, 964, 2537, 3596-3598, 4091
- Davidson, L. M. 4059
- Davie, S. 875, 876
- Davis, C. N. 3770
- Davis, J. H. 3701
- Davis, J. M. 965-968
- Davis, W. 471, 969
- Dawson, A. F. 1586-1592
- de Groot, P. 629, 905, 906, 1890
- de Gryse, J. J. 970-974
- de Vos, A. 975
- Dearborn, R. G. 976, 2036, 2788
- DeBach, P. 977

- DeBoo, R. F. 455, 651, 978-995, 1347, 1687, 1688, 2723
- DeGraaf, R. M. 888
- DeLand, L. F. 1842
- DeLeon, D. 996
- Delisle, A. 997
- Delisle, J. 2417
- Dell, T. R. 998
- DeLuca, M. A. 2428
- Delucchi, V. 777, 2973, 3232, 3361
- DeMars, C. J. 4021
- Denno, R. F. 3093
- Denton, R. E. 999-1008, 1874, 3729, 3773
- Derry, C. 2126
- Desaulniers, R. 1009-1014, 2306, 2988, 2989, 3474-3477
- Descoins, C. 4057
- Deshon, R. E., Jr. 517
- Devine, M. E. 1015-1017, 3808-3812
- DeWeese, L. R. 1018, 1019, 4314
- Dewey, J. E. 1020-1031, 1110, 1111, 1279, 1386, 1387, 1722, 1822, 1996, 2119, 2363, 3007, 3145, 3624
- Dickerson, T. C. 3109
- Dickison, R. B. B. 1032, 1033
- Dickson, J. G. 1817, 1818, 2797
- Dickson, W. 2692
- Dilworth, T. G. 1034, 1035
- Dimond, J. B. 552, 568, 757, 1036-1070, 1267, 1564, 1834, 1854, 1959, 1988, 2079, 2231, 2518, 2543, 2545, 2627, 2663, 2814, 3374, 3541, 3542, 3544
- Dines, R. E. 1071
- dinh Phu, T. 1435
- Dirks, C. O. 1123
- Dixon, C. 1072
- Dixon, J. C. 339, 1073-1077
- Dixon, W. N. 1078
- Dobell, J. V. 1035
- Dobesberger, E. J. 1079-1083
- Dobos, P. 145, 146
- Dobson, C. M. 1084, 1197, 2471, 2571-2574
- Dodge, H. R. 1085-1088
- Doe, K. 1216
- Doerner, R. G. 1089
- Doganlar, M. 1090
- Doidge, D. F. 852, 1091-1095, 4262-4264
- Dolph, R. E., Jr. 1096
- Dominion Department of Agriculture, Science Service--Division of Entomology 1097-1107
- Dooling, O. J. 1026, 1108-1111, 1472, 1561, 1997, 3844-3846
- Dorais, L. 50, 486, 1112-1116, 1578
- Dore, A. 1117
- Dowden, P. B. 560, 1118-1124

Drapek, R. J. 1194	Ebel, B. H. 1649
Dreistadt, S. H. 920	Eckler, J. 1792
Driver, W. R. 3730	Eco-Analysts, Inc. 1150-1152
Drooz, A. T. 334, 1125, 1827, 2159	Ecobichon, D. J. 891, 1153
Drury, W. H. 1126	Eder, R. G. 1571, 2362, 3630, 3631
Dube, N. R. 1127	Edmonds, R. L. 2410
Dubendorfer, A. 3523	Edson, D. T. 1154
Dubois, N. R. 1128, 2078	Edwards, D. K. 1155
Dubreuil, S. H. 1998, 3847	Edwards, J. C. 1156
Duckles, C. K. 3106, 3108	Egan, T. H. 655, 702, 1157
Duffy, J. R. 2195, 4308	Eggen, D. A. 45, 46
Dumbauld, R. K. 1129, 1130	Eiber, T. 2495, 2496
Duncan, D. P. 1825, 2028, 2032	Eichlin, T. D. 932
Dunkelblum, E. 1131	Eidt, D. C. 340, 1158-1180, 1556, 2469
Dunn, G. A. 1132, 3032	Ekblad, R. B. 227, 231, 232, 235, 236, 239-241, 1181-1183, 1327, 3316, 4295
Dunn, M. B. 1133, 1134	Elgee, D. E. 1184, 2488
Dunphy, G. B. 1135-1137	Elias, L. 875, 876
Durfee, J. 1138	Eller, R. Y. 1185
Durling, D. S. 2572	Elliot, K. R. 1186, 1187, 2358
Durzan, D. J. 1139-1144, 3341	Elliot, N. C. 3416
Dyer, L. J. 1145	Elliott, J. C. 3280
Dyer, R. 1146, 2766	Elliott, K. R. 1188-1192
Earlewine, B. M. 3316	Elliott, M. 1193
Easton, R. W. 1944	Elliott, N. C. 1194, 3396, 3412, 3413
Eaton, C. B. 1147-1149	Elner, J. K. 1195

- Elwell, R. 1196
- Embree, D. G. 1197-1200, 1877, 3599
- Emond, F. J. 1201, 1202, 2851, 2900, 2901, 3142, 3143
- Engelby, O. 30
- Ennis, T. J. 156, 1203-1208, 1784, 3064, 3248
- Environment Canada 1210
- Environment Canada, Lands Directorate 1209
- Environment New Brunswick 1211
- Environmental Monitoring Committee 1212, 1213
- Erdle, T. A. 2219
- Erickson, G. 1214
- Erickson, R. D. 63, 64, 853, 1215
- Erikson, G. W. 2497
- Ernst, B. 1216
- Erskine, A. J. 1217, 2856, 2857
- Estabrooks, G. F. 2573-2577, 2580
- Euler, D. L. 29
- Evans, D. 1218-1220
- Evans, H. J. 218, 529, 1221, 1222
- Evans, K. E. 888
- Evenden, J. C. 1223-1256, 1990
- Everitt, R. 2414
- Everson, D. O. 1913
- Evert, F. 373
- Ewan, H. G. 335
- External Affairs Canada 1257
- Eyre, F. H. 1395
- F. L. C. Reed & Associates Ltd. 262
- Falk, J. 1258, 1259
- Falls, J. B. 4312
- Famous, N. C. 2768
- Farrar, P. A. 3278
- Fast, P. G. 1173, 1260-1269, 3064, 3090
- Faulkner, P. 1710
- Fauss, D. L. 1270
- Fellin, D. G. 701, 703, 1271-1288, 1843, 3292-3295, 3729, 3731, 3732, 3735
- Fellows, E. S. 1289
- Felt, E. P. 779
- Fenderson, O. C. 4023
- Fensom, D. S. 1290, 2906
- Fereshtehkhrou, S. 1291, 1292
- Ferguson, D. E. 1293, 1294
- Ferguson, R. H. 1295
- Fernald, C. H. 1296
- Ferrell, G. T. 1297, 1298
- Fettes, J. J. 211, 581, 1299-1306, 2681, 3476, 3477, 4134
- Fiddick, R. L. 1307-1311, 3182, 3369
- Fiedler, C. E. 705

Field, D. B. 1312, 1313, 2060	Folger, D. 1126
Filip, G. M. 3859	Foltz, J. L. 51-53, 1348-1351, 2326
Filuk, B. 1314	Forbes, R. S. 1352-1359, 2471, 3030, 3031
Findlay, G. M. 1315	Force, J. E. 1360
Findlay, J. A. 1316, 1317, 2196	Ford, R. P. 1361-1369, 2022, 3196, 3648
Finley, R. B., Jr. 1318, 2702	Forrest, S. C. 662
Finnegan, R. J. 1319, 2417	Forsberg, C. W. 1370
Finney, J. R. 1320, 1321	Fosbroke, D. E. 60, 1371-1373
Finnis, M. 1700	Fosbroke, S. 1374
Fisher, R. A. 74, 1171, 1172, 1322-1324, 2470, 2680	Foster, H. R. 1375
Fitzpatrick, J. 38	Fowle, C. D. 1376, 1377
Flagg, L. N. 1325	Fowler, D. P. 2278
Flake, H. W., Jr. 2387	Fowler, G. W. 1378-1383, 2135, 2136, 2145, 3397, 3414-3417, 4241
Flannagan, J. F. 1326	Fowler, R. F. 1384, 1385
Flavell, T. H. 500, 1327-1329, 3848	Fox, R. C. 335
Fleet, R. R. 1817, 1818, 2797	Fox, R. S. 4309
Fleming, R. A. 1330-1336	Franc, G. C. 496, 1386, 1387
Fletcher, R. M. 3036, 3253	Francis, B. 2348, 2349
Flexner, J. L. 1337, 1338, 2544, 2549	Francis, S. H. 1388
Flickinger, E. L. 2916	Francoeur, A. 1855
Flieger, B. W. 1339-1344	Frank, R. M. 60, 358, 1389-1396, 1832
Floyd, R. L. 1019	Franks, N. E. 1397
Flug, M. 802, 898, 1323	Franz, J. M. 1398, 1399
Fogal, W. H. 156, 1345, 1346, 3780	Fraser, D. A. 1454
Foisy, L. 1347	Fraser, K. A. 2575-2580

Fraser, M. 3566
 Fraser, T. 3566
 Frear, S. T. 1400, 1401
 Frech, D. 4060
 Freeman, P. 322
 Freeman, T. N. 1402-1408
 Freitag, R. 1409, 1410
 French, J. 3086
 Frishknecht, M. L. 1411
 Fullarton, S. 4162
 Fuller, L. R. 2075
 Furniss, M. M. 1412, 1413
 Furniss, R. L. 1147, 1414-1418
 Furyaev, V. V. 1419
 Fye, R. E. 1420-1425
 Fyfe, H. A. 217, 1426
 Fyles, T. M. 1427, 4060
 Gaboury, G. 1115
 Gadek, K. 1428
 Gage, S. H. 1429-1431
 Gagne, R. 1432
 Gagnon, G. 1395
 Gagnon, J. D. 1433-1435
 Gardiner, J. G. 1436, 1437
 Gardiner, L. M. 1438, 1439

Gardner, A. K. 1440
 Garrett, B. 3425
 Garland, L. E. 26
 Garner, W. Y. 230, 1183
 Garrity, N. R. 622-625, 2854
 Garton, E. O. 1441-1443, 3685, 3686
 Gaudet, P. M. 1610
 Gautreau, E. J. 1444, 2668, 2669, 2851, 2901, 3141-3143
 Gauvin, D. A. 1445, 2517
 Geistlinger, N. J. 4264
 Genco, J. M. 1445, 2517
 George, D. A. 4015
 George, J. A. 2888
 George, J. L. 1446-1448
 Georgeson, E. 3514-3518
 Gerhold, H. D. 650
 Gertjeansen, R. O. 1449, 1781
 Gesner, G. N. 2488, 3993
 Getchell, A. S. 1043, 1048, 1063-1065, 2814
 Ghent, A. W. 1450-1454
 Gibbs, C. 1455
 Gibbs, K. E. 305, 869-872, 1456-1465, 2959, 2961, 2962, 3408, 3824, 3825, 3832
 Gibson, A. 1466, 1469, 1470
 Gibson, A. L. 1467, 1468

- Gibson, C. 38
- Gibson, H. R. 1471
- Gibson, K. E. 1472, 1473, 1996, 3631
- Giese, R. L. 772, 773
- Giguere, P. 3651
- Gilbert, A. M. 1474
- Gilbert, A. S. 1475
- Gilbert, F. F. 1476
- Gilbert, R. C. 1477, 1478
- Gilbert, S. 3280
- Gill, D. R. 380, 382, 843, 895, 916, 1071, 1154,
1397, 1445, 1449, 1562, 1636, 1795, 1894,
1902, 1976, 3022, 3303, 3382, 3431, 4024, 4288
- Gillette, N. L. 1479, 3120-3122
- Gillman, L. S. 1480
- Girouard, J. 1481
- Glen, R. 1482, 1483
- Glovinsky, M. 1484
- Gobeil, A. R. 1485
- Gochnauer, T. A. 587, 2952
- Godin, M. E. 3995
- Golec, P. J. 506
- Goodenough, D. 1592
- Goodwin, R. H. 3330
- Gooley, W. R. 1486, 1487
- Gordon, A. G. 1488
- Gorham, J. R. 1489
- Gosling, N. W. 1490
- Gottfried, G. J. 3166
- Govett, R. L. 222, 503, 1491, 3430-3432
- Goyer, R. A. 324
- Gradwell, G. R. 3977
- Graeber, H. 303
- Graham, D. A. 1492
- Graham, K. 1493-1495
- Graham, R. J. 1496, 1497
- Graham, R. T. 1498
- Graham, S. A. 1499-1511
- Gramlich, F. J. 1512, 1883, 1884
- Granett, J. 564-567, 1513-1518, 1801, 1972,
2416, 3073, 3087, 3137
- Grant, C. D. 1519, 1520
- Grant, G. G. 1521, 1525, 2424-2426, 2428, 2664,
3064, 3258, 3387, 3683, 4057, 4060
- Grant, J. 1522
- Grantham, B. L. 1465, 1523, 1524
- Gray, T. G. 1525, 3368
- Green, A. K. 3627
- Green, G. W. 1526, 1527, 4136
- Greenbank, D. O. 1324, 1528-1540, 2472-2474,
2488, 2491, 2658, 3745, 3746
- Greene, S. K. 562

Greenhalgh, R. 150, 509, 597, 801, 1009, 1715,
2418, 2855, 2919, 2987, 3680, 3985, 4259

Gregg, T. 1541

Gregory, G. R. 1779

Grigal, D. F. 2748

Grimble, D. G. 1, 49, 50, 229, 310, 480, 900,
1045, 1061, 1112, 1113, 1128, 1264, 1369,
1542-1546, 1552, 1569, 1575, 1806, 1807,
1842, 1900, 1941, 2019, 2039, 2129, 2275,
2286, 2287, 2349, 2361, 2536, 2626, 2876,
3239, 3302, 3304, 3345, 3411, 3413, 3416,
3439, 3456, 3532, 3536, 3687, 3805, 3806,
3826, 4014, 4103, 4185, 4250

Grisdale, D. 902, 1547-1549, 3088

Gross, H. L. 1550, 1757, 1772, 1773

Gruba, A. G. 4155

Gruell, G. E. 1551

Gunner, H. B. 1552

Guscott, R. 3516-3518

Gustafson, J. F. 3311

Guthrie, F. E. 4053

Haack, R. A. 323

Hacker, S. C. 1553, 1788, 1844-1846, 1856

Haddon, W. F. 3109

Haggis, M. J. 1033

Haglund, S. 501

Haines, D. A. 3263

Haissig, K. 3008, 3009

Haliburton, W. 3487

Hall, A. G. 1554

Hall, D. J. 2012

Hall, G. A. 1555

Hall, H. A. 1556

Hall, J. P. 1557

Hall, K. C. 1558

Hall, R. J. 1824, 2560, 2700

Halteman, W. A. 2051, 3535

Hamel, D. R. 1559-1561, 2364, 3849

Hamel, L. 1573

Hanington, H., Jr. 1562

Hankinson, D. 512, 513

Hanover, J. W. 1563

Hansen, H. L. 96

Hansen, R. W. 1564-1567

Hanson, F. 17

Hanson, P. M. 1568, 1569

Hara, A. H. 1892

Hard, J. S. 1570-1572, 3094, 3628

Harding, G. D. 3682

Hardman, J. M. 3411

Hardy, Y. 309, 892, 1114, 1573-1579, 3478, 3960

Harmsen, R. 1580

Harnden, A. A. 904, 908, 909, 913, 1758-1770,
3436

Harper, J. D. 1581

Harrell, M. O. 323	Hayes, F. 1031
Harrington, W. 2571-2580	Haynes, D. L. 1645
Harris, J. W. E. 1582-1593, 3369, 3756, 3758	Hayslett, H. T., Jr. 1646, 1647
Harris, M. 1594	Hazelton, L. W. 1648
Harris, M. M. 821, 3140, 3640	Hedden, R. L. 281, 1979, 4246
Harshberger, D. 2918	Hedin, P. A. 747
Hart, A. C. 1595, 1596	Hedlin, A. F. 1649, 3831
Hartkorn, F. 1709	Heikkinen, H. J. 1981
Hartling, L. K. 740, 1597	Heimbürger, C. C. 1650
Harvey, G. T. 1598-1616, 2034, 2794	Heimpel, A. M. 74, 1651-1653, 2680, 3479
Harvey, J., Jr. 230, 1183	Heinrichs, E. A. 1654-1656
Harvey, R. D., Jr. 1617	Heinselman, M. L. 1657
Haskett, M. J. 3010	Helburg, L. 2047
Hassell, M. P. 3977	Heller, R. C. 25, 1658-1661, 4039
Hastings, A. R. 280, 281, 1214, 1361, 1618-1620, 2497	Helson, B. V. 1662, 1663
Hastings, E. 1621	Helzner, R. 1664
Hatch, C. L. 2545	Henderson, C. B. 746, 747
Hatcher, J. D. 1622	Henderson, M. 1370
Hatcher, R. J. 1623-1628	Hendren, K. H. 1665
Hattie, J. 3518	Hengel, P. W. 1280
Hatton, J. V. 1629-1637	Henny, C. J. 1018, 1019, 4314
Haugen, G. 1638	Henry, E. 1370
Haverty, M. I. 998, 1639-1641, 3123, 3124	Henry, J. E. 1666
Hawboldt, L. S. 202, 1642, 1643	Hensley, M. M. 1667
Hay, E. 1644	Henson, W. R. 1668-1670, 4135

- Heron, R. J. 1671-1675
- Hertz-Brown, E. 1676
- Hester, D. A. 1677, 1678, 4169
- Hew, C. L. 1679
- Hewitt, C. G. 1680-1684
- Heybroek, H. M. 2354
- Heyd, R. L. 1685, 2670, 2671, 3011
- Hildahl, V. 990-992, 1686-1688, 2900, 2954
- Hildebrand, D. M. 2111
- Hildebrand, M. J. 2610-2612, 2614-2617, 4309
- Hill, M. K. 1445, 2517
- Himel, C. M. 1689-1694
- Hink, W. F. 3521
- Hiratsuka, Y. 1695, 1696
- Hirvonen, R. 1697
- Hitt, S. M. 547
- Hix, D. M. 1698
- Hobart, J. 1699
- Hodgkinson, R. S. 1700
- Hodson, A. C. 1701-1705, 1825, 2027-2032
- Hofacker, T. H. 521, 1706, 2020
- Hoff, R. J. 1707
- Hoffman, C. H. 1708
- Hoffman, J. A. 2037
- Hoffman, J. T. 3312
- Hoffman, R. S. 1709
- Hoffmann, I. 4307
- Hogan, H. E. 2230
- Hohmann, A. W. 1710
- Holder, D. A. 1795
- Holland, D. G. 1711
- Holling, C. S. 778, 1712-1715, 1881, 2132, 2892
- Holmes, J. A. 40
- Holmes, S. B. 1716
- Holsten, E. H. 1525, 1717-1719
- Holt, F. E. 1720
- Holt, L. 1721
- Honing, F. W. 716, 1027, 1722-1724
- Hook, J. 1375
- Hopewell, W. W. 542, 1725-1730, 2746
- Hopping, G. R. 1731-1734
- Hoskins, W. H. 2694
- Hosman, K. P. 663
- House, H. L. 830, 1735-1740
- House, L. O., IV 512, 1676, 3530
- Houser, E. L. 1558
- Houseweart, M. W. 1078, 1741-1752, 1832-1834, 1843, 1847-1855, 1918, 2049-2052, 3535
- Howard, B. 1753
- Howard, L. O. 1754
- Howe, G. J. 1315

- Howie, E. L. 210, 2661
- Howse, G. M. 131-137, 393, 726, 727, 904-906, 908, 909, 913, 994, 1755-1774, 1890, 2421-2423, 2613, 3065, 3089
- Hrubik, P. 1775
- Hubbard, H. B., Jr. 3012
- Hudak, J. 156, 456, 626, 1173, 1526, 1776, 2468, 2690, 2794, 2923, 2999, 3965
- Hudes, E. S. 1777
- Hudson, D. W. 2661
- Hudson, S. T., Jr. 1778
- Huff, D. 1779
- Huffaker, C. B. 1780
- Hughes, E. L. 259
- Hughes, M. 1781
- Hulbert, P. J. 1782, 1783
- Hulme, M. A. 1784, 1898
- Hulsey, C. T. 619
- Hunt, R. S. 1220
- Hunter, L. 242
- Hunter, M. L., Jr. 1567, 1785-1788
- Huot, I. 2829
- Huot, L. 2828
- Hurst, J. W., Jr. 1325
- Hussain, M. A. 1789
- Hussey, N. W. 610
- Hutchinson, T. C. 1556
- Hutchison, P. M. 3480
- Hydorn, S. B. 1790, 1791
- Hynson, J. R. 1792
- Ide, F. P. 1793
- Ignatowicz, S. 1794
- Imada, S. E. 1795
- Ingram, W. A. 1796, 1797
- Inscoe, M. N. 1798
- Irland, L. C. 1799-1806, 3195
- Irving, H. J. 1072, 1807-1809, 4095
- Ishihara, R. 1810
- Isler, D. A. 966-968, 1811, 1812, 4303
- Ives, W. G. H. 1813-1816, 4251
- Iwai, P. J. 2300, 2301
- Iwantsch, G. F. 3999
- Jackson, J. A. 1817, 1818, 2797
- Jacobson, M. 1819
- Jaeger, V. A. 1145
- Jago, R. D. 1134
- James, C. L. 1820
- James, R. L. 1473, 1821-1823, 1996, 2119, 2362, 3312
- Janes, N. F. 1193
- Jano, A. P. 1824
- Janson, R. G. 1709
- Jansons, V. 375, 376, 3771, 3772

- Jaquith, P. H. 1825
- Jaszkowski, R. 3859
- Jaynes, H. A. 1124, 1148, 1149, 1826-1829
- Jeffrey, W. W. 1830
- Jeglum, J. K. 3424
- Jenkins, M. J. 1028-1030
- Jennings, D. T. 5, 282, 283, 816, 886, 887, 889,
1078, 1746-1752, 1788, 1791, 1831-1856, 1918,
2051, 3032, 3535, 3832
- Jennings, P. R. 1563
- Jerrett, P. A. 18
- Jobin, L. J. 48, 1857
- Johal, S. S. 1633
- Johannesen, M. M. 7
- Johannsen, O. A. 1858-1860
- Johnson, D. R. 1861, 2288-2291, 3011, 3012,
3344
- Johnson, D. W. 1862
- Johnson, K. B. 1863
- Johnson, P. C. 1088, 1288, 1864-1874, 3733
- Johnson, P. L. 25
- Johnson, R. 2114
- Johnson, S. A. 1875
- Johnson, V. E. 1876
- Johnson, W. L. 1721
- Johnston, D. W. 1195
- Johnston, J. H. 1200, 1877
- Johnston, R. N. 1878
- Johnston, W. F. 1879
- Jokela, J. J. 4279
- Jones, C. G. 2227, 2228, 4112-4117
- Jones, D. D. 778, 1713, 1714, 1880, 1881, 2132
- Jones, J. R. 2292
- Jones, M. J. 1882
- Jones, W. A., Jr. 2844
- Joseph, P. 2344
- Julien, G. 1216
- Julin, A. M. 1883, 1884
- Juneau, A. 3474, 3475, 3481-3487
- Kadunce, R. E. 1063-1065
- Kagalwala, M. 1445, 2517
- Kamijo, K. 1885, 3045
- Kaneko, T. M. 2081
- Kao, M. H. 1679
- Kapler, J. E. 1076
- Karpinski, C., Jr. 1886, 4238, 4239
- Katagiri, K. 1887
- Katterman, L. 1888
- Kaupp, W. J. 904, 906-910, 1889, 1890, 3065,
3089, 4207-4210
- Kaya, H. K. 62, 1891-1893, 1978, 4123
- Keane, R. 3328
- Kearby, W. H. 325

- Keef, R. C. 1894
- Keefe, K. W. 3708, 3709
- Keen, F. P. 1895
- Keenan, R. 1896
- Keenleyside, M. H. A. 1897
- Keith, J. A. 1034
- Keizer, A. J. 2227, 2228
- Kelleher, J. S. 1898
- Kelley, R. S. 46, 1899, 1900, 3692
- Kelly, B. 1901
- Kelly, D. J. 3620
- Kelly, W. 1902
- Kemp, W. P. 313, 1047, 1903-1917, 3803
- Kendall, D. M. 1918
- Kendeigh, S. C. 1919
- Kennedy, D. M. 1397
- Kennedy, G. G. 1324, 2392, 3800
- Kennedy, H. 1920
- Kennedy, P. C. 3591
- Kessler, B. L. 1921
- Kettela, E. G. 50, 156, 456, 1116, 1197, 1264, 1922-1948, 2472-2478, 2488, 2491
- Kevan, P. G. 1949
- Kimball, A. J. 1950
- Kimball, R. A. 3125-3127
- Kimmins, J. P. 1951
- Kingsbury, P. D. 582, 588-593, 1173, 1952-1958, 2015, 2395, 2952, 3826
- Kingsley, N. P. 1295
- Kingston, D. G. O. 2247
- Kirby, C. A. 1959
- Kittams, W. H. 1621
- Kittredge, M. 1044
- Klaiber, H. M. 478, 479
- Klein, W. H. 267, 581, 707, 763, 930, 1013, 1023, 1041, 1277, 1302, 1308, 1474, 1492, 1532, 1618, 1648, 1720, 1937, 1940, 1960-1969, 1977, 2013, 2148, 2149, 2389, 2676, 2708, 2986, 3259, 3260, 3264, 3406, 3783, 3976, 3981, 4160
- Kleinschmidt, S. M. 261, 1970, 1971, 3328
- Kline, A. W. 2220
- Klingman, G. C. 1972
- Knapp, K. A. 632, 633, 1473, 1823, 2119, 2293
- Knauer, K. 1973, 3784
- Knauf, W. 611
- Knell, J. D. 1974
- Knight, F. B. 51-53, 552, 1349, 1350, 1511, 1788, 1844-1846, 1856, 1975-1981, 2326
- Knight, G. 1982
- Knopf, J. A. E. 237, 1964, 1965, 1983-1986, 3629
- Knox, S. 1987, 3518
- Knupp, D. M. 1988
- Koch, E. 1989, 1990
- Koerber, T. W. 1649, 3007

- Kohler, S. 1991-1998, 3846, 3847
- Kolbe, E. L. 1999
- Koller, C. N. 2000, 2322, 2327
- Koller, N. 4226
- Kondo, E. S. 2001
- Koot, H. P. 56, 57, 1092-1094, 2002-2005, 4265, 4272
- Koschatzky, K. H. 611
- Kotchian, N. M. 1017, 2006, 2007
- Krall, J. H. 304, 1047, 2008-2011
- Kramer, J. D. 1397
- Krauth, S. J. 2012
- Krebs, C. F. 2013
- Kreutzweiser, D. P. 2014, 2015
- Kristmanson, D. D. 2904
- Kroll, J. C. 1817, 1818, 2797
- Krywienczyk, J. 141, 915, 2016, 2017
- Krzymien, M. 875, 876
- Kucera, D. R. 1, 49, 1113, 1369, 1569, 1575, 1842, 1900, 2018-2025, 2039, 2275, 3239, 3315, 3413, 3416, 3439, 3536, 3805, 4014, 4103, 4185
- Kuenen, L. P. S. 3383-3385, 3388
- Kulman, H. M. 1825, 2026-2033, 3357, 4222
- Kurstak, E. 914, 2622, 3523, 4200
- Kushner, D. J. 2034
- Kydonieus, A. F. 2035
- LaBonte, G. A. 2036
- Lachance, D. 1973
- Lafond, A. 1573
- Lageux, M. 2037
- Laks, P. 2391, 2393
- Lambert, R. 2038
- Lancaster, K. F. 2039
- Landgraf, A. E. 2040-2042
- Lang, J. M. 2043, 2044
- Langelier, L. A. 1441-1443, 3686
- Langridge, W. H. R. 2045
- Lanier, G. N. 1, 45, 46, 49
- Larson, J. E. 2046
- Larson, L. V. 3486
- Lauenroth, W. K. 802, 898, 1323
- Lauer, W. L. 3283
- Laurent, T. H. 1719
- Laut, J. G. 2047, 2109, 2358
- Lautenschlager, R. A. 2048
- Lauzon, H. 3090
- Lavallee, A. 1784
- Lavigne, D. R. 739, 2220
- Lavigne, R. J. 1982, 2922, 3138
- Lawless, M. M. 1441
- Lawrence, H. D. 530, 1221, 2229, 2422, 2423

- Lawrence, R. K. 1747, 1748, 2049-2052
- Lawson, T. 2053
- Layton, C. R. 2901, 3143
- Le Blanc, H. 2054
- Leach, S. 352, 353
- Leatherman, D. A. 2047, 2055, 2103, 3603, 3604
- LeBarron, R. K. 2056, 2057
- Leblanc, H. 2058
- Leckie, D. G. 2059
- Lee, T. H. 2060
- Leech, R. E. 1409
- Leeper, P. C. 10
- Lehela, A. 2061
- Leius, K. 2062-2064
- Lejeune, R. R. 1314, 1426, 2065-2069, 2104, 3103
- Leonard, D. E. 351-355, 2000, 2070-2073, 2329, 2523, 3398, 3833
- Leroux, E. J. 2640
- Leslie, A. P. 2074
- Lessard, E. D. 1711, 2075-2077, 2839-2841
- Lewis, D. 2536
- Lewis, F. B. 229, 310, 900, 1061, 1112, 1128, 1264, 1552, 1807, 1941, 1966, 1967, 2078-2081, 2129, 2349, 2361, 2536, 2626, 2627, 2876, 3304, 3456, 3532, 3806, 4022
- Lewis, F. R. 287
- Lewis, K. R. 2082
- Lewis, L. 2536
- Lewis, S. 2083
- Leznoff, C. C. 1427, 4060
- Lidstone, R. G. 594, 2221
- Liebhold, A. M. 2084-2087, 4004-4007, 4009, 4040
- Lillesand, T. M. 576
- Lim, K. P. 1081-1083, 1321, 1679, 2088, 2089, 2999
- Lindquist, O. H. 2090-2094, 2494, 3176, 3177
- Lindsten, A. 2095, 2096, 4280
- Linnane, J. P. 345, 2097-2103, 3161, 3700, 3701
- Linteau, A. 1721
- Liscombe, E. A. R. 2104
- Lister, C. K. 2105-2111
- Little, C. H. A. 1174-1176, 3336-3341
- Livesey, F. 1558
- Livingston, R. L. 632, 764, 1473, 1823, 2112-2119, 2294, 3312, 3629
- Locke, R. R. 381, 382
- Lockhart, W. L. 1315
- Logie, R. R. 2952
- Lonergan, G. C. 2821, 3183, 3285, 3289, 3384, 3386
- Longworth, J. F. 2120
- Lood, R. C. 491, 501, 765, 2364
- Look, M. 2524, 2525, 3106, 3109, 3121, 3128

- Loomis, R. C. 521, 1706, 2020
- Lopushanski, S. M. 1142, 1143, 1346, 3780
- Lorimer, N. 2121-2123
- Lortie, M. 2124
- Losensky, J. 3205
- Lotan, J. E. 1712
- Loucks, O. L. 259
- Loughheed, T. C. 2125, 2226
- Loughton, B. G. 2126, 2127
- Lovestead, H. S. 2128
- Lowe, D. P. 1220
- Lu, K. C. 483
- Lublinkhof, J. 2129
- Lucas, B. A. 2147, 3121, 3122
- Lucuik, G. S. 2130, 3250-3253, 3256
- Ludwig, D. 2131, 2132
- Luebbe, R. 234
- Lund, D. 1522
- Lund, H. G. 512, 1676, 3530
- Lund, Wilk, Scott and Goodall 2133
- Lundholm, B. 2515, 3148
- Lynch, A. M. 2134-2146, 2533, 2552, 2553, 4237, 4242-4245
- Lyon, R. L. 1479, 2147-2151, 2524, 2526, 3106, 3107, 3121, 3129
- Maahs, W. 2152
- MacAloney, H. J. 560, 2153-2159, 2872, 2873
- MacArthur, R. H. 2160
- MacCall, C. D. 2161-2165, 2571-2577, 2580
- MacCallum, M. E. 2166
- Macdonald, D. R. 1316, 1317, 2167-2197, 2479, 4094, 4096-4100
- MacDonald, J. E. 2198
- MacDonald, J. P. 2199
- MacDonald, J. R. 2200
- MacDonald, L. M. 2201, 4060, 4063
- MacFarlane, M. D. 724
- MacGillivray, H. G. 1177
- MacGregor, D. R. 2017
- MacKay, A. W. 2202-2204
- MacKay, M. R. 543, 2205-2207
- Maclean, A. L. 576
- MacLean, D. A. 156, 260, 473, 480, 1419, 2208-2222, 2581, 2907, 2908, 2999
- Maclean, W. 4061
- MacLeod, D. A. 1346
- MacLeod, D. M. 2125, 2223-2226
- MacLeod, L. S. 2227-2229, 3771, 3772
- Madding, R. P. 2230
- Madill, R. J. 1697
- Madore, C. D. 566, 1516, 2231
- Magasi, L. P. 2232-2245, 2880, 3782

Magnuson, H. A. 2246	Marsh, J. W. 968, 1659, 2297, 2874
Mahendrappa, M. K. 2247	Marshall, H. G. W. 2567
Maine Bureau of Forestry 2248	Marshall, J. P. 1473
Maine Department of Conservation, Bureau of Forestry 2249	Marshall, J. W. 783
Maine Department of Conservation, Maine Forest Service 2250-2252	Marshall, K. B. 2298
Maine Forest Service 2253-2267	Marshall, R. 2299
Maine Forestry Department 2268	Marshall, W. K. 150, 509, 597, 801, 1009, 1715, 2855, 2919, 2987, 3680, 3985, 4259
Mainville, M. 1579	Martignoni, M. E. 2300, 2301, 3164, 3330
Maitlen, J. C. 4015	Martineau, R. 348, 349, 454, 457-462, 968, 994, 2302-2311, 3487
Majcen, Z. 1395	Marty, R. 2312, 2313
Maksymiuk, B. 966, 967, 1811, 2269-2274	Mason, W. R. M. 2314-2316
Malcolm, S. 1066, 1067	Mathers, W. G. 2317-2319, 4173
Malerba, P. J. 2275	Mathieu, P. 2320
Mallet, V. N. 2276, 2277	Mattson, W. J. 53, 1350, 2321-2327
Manley, S. A. M. 2278	Maw, M. G. 830-832, 2328
Manuwal, D. A. 2279	Maxwell, F. G. 1563
Maramorosch, K. 3523	Maxwell, L. 4178
Marancik, J. 2280	May, B. 2329
Maranda, J. 3324	May, E. E. 2330, 2331
Markin, G. P. 231, 232, 237, 1861, 1984, 2281-2291, 3605, 3629, 4295	May, R. M. 2332
Marks, D. B. 2571-2573, 3048	May, T. A. 2333
Markstrom, D. C. 2292	Maybury, R. B. 801
Marsalis, R. L. 240, 241	McCarthy, J. 2334, 2335, 4238, 4239
Marsden, M. A. 2293-2296	McCarthy, T. F. 509, 2336

- McCaughey, W. W. 704
- McClain, K. M. 29, 246, 1756
- McClintock, T. F. 2337
- McClure, M. 38
- McClure, M. S. 3093
- McComb, D. 713, 2338-2344, 2686
- McConnell, T. 2344
- McCormack, M. L., Jr. 2345
- McCormack, W. W. 210
- McCowan, V. F. 167, 2346, 2347
- McCreery, L. 2348, 2349, 2509, 3537, 3538
- McCullough, R. D. 2350, 2793
- McCune, B. 2351
- McDaniel, E. 2352
- McDermott, R. E. 650
- McDonald, G. I. 2353-2357
- McDonald, H. 542
- McDonnell, G. R. 3589
- McDougall, G. A. 341, 342, 635, 2469, 2477, 2478, 2480-2483, 3046, 4008
- McDowall, L. L. 510, 2358, 3437, 3438
- McElroy, W. D. 2428
- McEvoy, T. J. 2359
- McFadden, M. W. 2360
- McFarlane, J. W. 2989, 2992
- McGauley, B. H. 2361
- McGregor, M. D. 700, 766, 770, 1025, 1968, 2362-2370, 3849, 4178, 4180
- McGuffin, W. C. 2371
- McGugan, B. M. 2372-2376
- McIntyre, T. 4041
- McIsaac, J. E. 2906
- McKeague, M. A. 1685, 2670-2672
- McKnight, M. E. 583, 1844-1846, 1856, 2377-2389, 4170
- McLaughlin, M. F. 1972
- McLean, J. A. 68, 2390-2393, 3130
- McLeod, B. B. 582, 584-597, 1173, 1956, 1957, 2394-2396, 2952
- McLeod, C. H. 2397
- McLeod, J. M. 2398-2403, 2418, 4101
- McLintock, T. F. 2404-2409
- McManus, M. L. 2410
- McMorran, A. 2411-2413
- McMullen, L. 3369
- McNamee, P. 2414
- McNeil, J. N. 2403, 2415-2418
- McPhee, J. R. 394, 902, 904-913, 1770, 1890
- McRae, D. J. 2419
- McVey, D. G. 1795
- Meades, W. J. 1173, 2420, 2999
- Meating, J. H. 1178, 1757, 1762, 1773, 2421-2423

- Meighen, E. A. 1521, 2424-2428, 2664, 2665, 3683
- Meikle, O. A. 2429, 2430
- Melachrinoudis, E. 3194
- Melgaard, S. 3164
- Mellanby, K. 1699, 4054
- Melvin, J. C. E. 511, 1444, 2931, 3501, 3502, 3614, 3615, 3653
- Menard, D. 2928
- Mercer, R. 2692
- Mercier, J. C. 2431
- Merkel, E. P. 215, 1649, 2432
- Merski, E. 477
- Mertins, J. W. 837
- Merz, R. W. 2433
- Meso, S. W. 2434-2440
- Messenger, P. S. 1780
- Meyer, H. E. 605, 1031, 1329, 2441, 3631, 3843, 3848, 3849
- Michigan Department of Conservation, Division of Forestry 2442
- Mika, P. G. 3642, 3644, 3645
- Miliczky, E. R. 2443, 2444
- Miller, A. 2445, 2446
- Miller, C. A. 156, 1173, 1430, 1431, 1945, 2447-2491, 2655-2658, 2794, 3047, 3746
- Miller, E. E. 2492
- Miller, G. E. 3199
- Miller, I. 270, 271
- Miller, J. D. 2493
- Miller, R. 501
- Miller, W. J. 2494
- Millers, I. 238, 284, 325, 337, 2349, 2495-2509, 3537, 3538
- Millikin, R. L. 2396, 2510
- Mills, H. B. 2511
- Mills, N. J. 2512, 2513
- Milne, G. R. 2514
- Miltenburger, H. G. 2515
- Milton, J. 2516
- Mineau, W. E. 803-806
- Minerowicz, E. A. 1445, 2517
- Mingo, T. M. 1458-1463, 2518, 2519
- Ministere des Terres et Forets 2520
- Minks, A. K. 15
- Minnemeyer, C. D. 2521, 2522
- Minot, M. C. 2523
- Miskus, R. P. 67, 605, 2524-2526, 2912, 3107, 3108, 3778
- Mitchell, B. K. 2527-2531
- Mitchell, E. R. 2035, 3218, 3235
- Mitchell, R. 760, 1284, 1475, 1707, 2116, 2152, 2296, 3645, 3859
- Mitchell, R. T. 1447, 1448, 2532
- Moeller, G. H. 1199, 3570

- Mog, T. P. 2137-2140, 2533, 2534, 4238, 4239, 4244, 4246
- Mohamad, R. B. 1789, 2535
- Mohamed, A. K. A. 2536
- Moir, W. H. 547
- Molnar, A. C. 2537, 2538
- Moncrieff, S. M. 3757
- Monge, F. 3533
- Montgomery, B. A. 263, 1337, 1338, 1779, 2539-2554, 2771, 3149-3151, 3153-3155, 3399, 3411, 4244, 4245, 4248-4250
- Montgomery, M. 19, 314, 355, 1335, 2327, 2356, 2393, 2555-2557, 2848, 3293, 3305, 3371, 3688, 3739, 4013, 4245
- Monts, J. S. 65, 66, 854, 855, 2586, 2588, 2589
- Moody, B. H. 456, 1695, 2558-2565, 2798, 2999, 3965
- Moody, U. L. 1914
- Mook, L. J. 1431, 2566, 2567
- Mook, P. V. 2568, 4042
- Moon, F. L. 3316
- Mooney, H. A. 1712
- Moore, A. 1693, 1694, 2569, 2570, 2616-2620, 2990
- Moore, G. 3280
- Moore, J. M. 4110
- Moran, G. V. 1357, 1946, 2236, 2571-2580
- Morgan, M. G. 2211, 2488, 2581, 3333, 3334
- Morin, J. L. 164, 512, 513, 2582, 2583
- Morris, E. V. 2584-2589
- Morris, O. N. 156, 993, 1045, 1173, 1543, 2079, 2569, 2590-2627
- Morris, R. F. 212, 213, 342, 1530, 1531, 1535-1537, 2126, 2184-2192, 2197, 2454, 2458-2460, 2466, 2566, 2628-2662, 2675, 2677-2679, 2714, 2716, 2951, 4048, 4049, 4051, 4089
- Morrison, T. A. 1046, 1070, 2663
- Morse, B. W. 2693
- Morse, D. 1521, 2664, 2665, 3683
- Morse, D. H. 2666, 2667
- Morse, F. S. 325, 327, 328
- Mortensen, K. L. 582, 2668, 2669, 3141
- Morton, M. B. 3279
- Mosher, D. G. 1619, 2670-2673, 2759, 2761
- Mott, D. G. 293, 1047, 1049, 1068, 2655, 2656, 2658-2660, 2674-2684, 3328
- Mounts, J. 2685, 2686
- Moyer, M. 1664, 2687
- Mueller, P. J. 1411
- Muesebeck, C. F. W. 2688
- Muiry, J. M. 1148, 1149
- Mullins, E. J. 31, 43, 44, 152, 153, 163, 226, 266, 311, 312, 372, 445, 449, 472, 473, 515, 583, 602, 606, 644, 652, 701, 728, 745, 752, 874, 886, 893, 897, 899, 927, 933, 1032, 1039, 1040, 1072, 1079, 1080, 1157, 1271, 1272, 1290, 1293, 1330-1333, 1389, 1390, 1441, 1442, 1589, 1607, 1608, 1663, 1741, 1776, 1779, 1831, 1834, 1857, 1903-1907, 1921, 1958, 1975, 2059, 2089, 2115, 2134, 2135, 2146,

- 2209, 2216, 2217, 2321, 2390, 2420, 2421, 2513, 2514, 2539, 2540, 2555, 2556, 2696, 2697, 2717, 2722, 2726, 2738, 2790, 2889, 2904, 2905, 2910, 2994-2996, 3002, 3005, 3006, 3033, 3110, 3146, 3149, 3150, 3217, 3220, 3221, 3230, 3236, 3240, 3266, 3267, 3277, 3290, 3325, 3343, 3346, 3359, 3380, 3383, 3397, 3399, 3440, 3526, 3528, 3541, 3555-3557, 3601, 3622, 3623, 3636, 3641-3644, 3652, 3676, 3750, 3753, 3754, 3787, 3788, 3802, 3854, 3991, 4001-4003, 4005, 4012, 4027, 4040, 4137, 4146, 4161, 4227, 4236, 4237, 4243, 4276, 4281, 4282, 4291, 4297, 4298
- Mulloy, G. A. 2689
- Munro, J. A. 2690, 2692, 2923
- Munro, J. W. 2691
- Munson, A. S. 2693-2695, 3196
- Murakoshi, I. 353
- Murphy, C. F. 2696, 2697
- Murphy, J. 31, 43, 44, 152, 153, 226, 266, 311, 312, 372, 445, 449, 472, 473, 583, 602, 606, 644, 652, 701, 728, 745, 752, 874, 886, 893, 897, 899, 927, 933, 1032, 1039, 1040, 1072, 1079, 1080, 1157, 1271, 1272, 1293, 1330-1333, 1389, 1390, 1441, 1442, 1589, 1607, 1608, 1663, 1741, 1776, 1779, 1831, 1834, 1857, 1903-1907, 1921, 1958, 1975, 2089, 2115, 2134, 2135, 2209, 2321, 2390, 2420, 2421, 2513, 2514, 2539, 2540, 2555, 2556, 2696, 2697, 2722, 2726, 2738, 2790, 2889, 2904, 2905, 2995, 2996, 3002, 3005, 3006, 3033, 3110, 3146, 3149, 3150, 3217, 3220, 3221, 3230, 3236, 3240, 3266, 3267, 3277, 3290, 3325, 3343, 3346, 3359, 3383, 3397, 3399, 3440, 3526, 3541, 3555-3557, 3601, 3622, 3623, 3636, 3641-3644, 3652, 3676, 3753, 3754, 3787, 3788, 3802, 3854, 3991, 4001-4003, 4005, 4012, 4027, 4040, 4137, 4146, 4161, 4227, 4236, 4237, 4276, 4281, 4282, 4291, 4297, 4298
- Murray, R. L. 2670, 2671
- Murtha, P. A. 2698-2701
- Mussehl, T. W. 2702
- Myhre, R. J. 2694
- Myren, D. T. 1757, 1772, 1773
- Nadeau, J. P. 2703, 2704
- Nagel, R. H. 2705
- Nairn, L. D. 1673, 2682, 2955
- Nakamoto, R. 3344
- Narog, M. G. 3012
- Nash, M. R. 1620
- Nash, R. W. 2157, 2706-2708, 2874, 4092
- National Research Council of Canada, Associate Committee on Agricultural and Forestry Aviation 508, 580, 645, 1014, 2336
- National Research Council of Canada, NRC Associate Committee on Scientific Criteria for Environmental Quality 2709, 2710
- Naumann, J. R. 3296
- Neatby, K. W. 2711
- Neilson, M. M. 2712-2716
- Neisess, J. 2269, 2273, 3749
- Nelson, R. 2717
- Neuman, R. D. 1291, 1292
- New Brunswick Committee for Environmental Monitoring of Forest Insect Control Operations (EMOFICO) 2718
- New Brunswick Department of Lands and Mines 2719

- New Brunswick Department of Natural Resources 2720
- Newell, W. R. 964, 2237, 3498, 3499
- Newfoundland and Labrador Department of Consumer Affairs and Environment, Research and Assessment Branch 2721
- Nichols, T. 2722
- Nicholson, S. A. 725-728, 2723
- Nickerson, D. E. 2724
- Nicks, B. D. 2725
- Nielsen, P. M. 2810
- Nieuwenhuis, M. A. 2726
- Nigam, P. C. 156, 157, 1173, 1730, 2727-2746, 2991, 3345, 3991
- Nishijima, K. 2047
- Niwa, C. G. 1998, 3630, 3631
- Nolan, R. A. 1135-1137, 2747
- Nordin, J. O. 2748
- Northwest Forest Pest Action Committee 2749-2752
- Norton, G. A. 1881
- Nova Scotia Department of Lands and Forests 675, 2753-2758
- Nyrop, J. P. 1908, 2670-2672, 2759-2761
- Nystrom, C. 629
- O'Brien, D. S. 782-787
- O'Loughlin, J. 703
- O'Neal, J. 518, 1051
- Obarymskyj, A. 4318
- Obraztsov, N. S. 2762, 2935
- Oda, T. 3183, 3289
- Ohmann, L. F. 2763
- O'Keefe, T. G. 60, 1396, 2764, 2765
- Oliveri, K. W. 2766
- Oliveri, S. F. 2767, 2768
- Ollieu, M. 371, 2914
- Oloffs, P. C. 1789, 2535
- Olson-Elliott and Associates 2769
- Olson, C. E., Jr. 2146, 2334, 2335, 2770-2772, 4238, 4239
- Olson, H. 2773
- Olson, J. T. 2759
- Olson, T. 3280
- Ontario Department of Lands and Forests 2774, 2775
- Ontario Ministry of Natural Resources 2776
- Orchard, R. D. 2269, 2273, 2274
- Oregon Department of Forestry 2777-2779
- Oregon State Board of Forestry 3863
- Orr, G. F. 240, 241
- Orr, L. W. 1503, 2780-2784
- Orr, P. W. 2021, 2022
- Osawa, A. 2785
- Osborn, J. E. 2786

- Osgood, E. A. 1565-1567, 2443, 2787, 2788
- Ostaff, D. P. 163, 515, 1290, 2059, 2146, 2216, 2217, 2222, 2717, 2789-2792, 2910, 2994, 3380, 3528, 3750, 4243, 4250
- Ostrowsky, A. 3379
- Ott, F. T. 2793
- Otvos, I. S. 156, 896, 2564, 2565, 2794-2800
- Ouellette, G. B. 2307
- Outram, I. 2801-2813
- Owen, R. B., Jr. 1048, 1988, 2814
- Ozburn, G. W. 1409
- Packard, A. S. 2815-2817
- Paehlke, R. 2818
- Page, M. 2150, 2819, 3107
- Paim, U. 23, 24
- Palaniswamy, P. 2820-2824, 3183, 3184, 4163
- Palmer-Benson, T. B. 2825
- Pardy, K. E. 783-787, 2826, 2827, 3310
- Pare, F. 2828, 2829
- Pare, G. 2830-2832, 2926-2928
- Parent, B. 2833
- Parisella, S. 17, 19, 20
- Park, B. C. 828
- Parker, B. 2079
- Parker, D. E. 2834, 4158
- Parker, D. L. 1031, 2835-2843, 2966
- Parker, R. 1216
- Parkin-Clunie, J. 1146
- Parkman, P. 2844
- Parks Canada 2845
- Parks, G. H. 463
- Parrott, W. C. 721, 2578
- Pashley, D. P. 2846
- Patch, E. M. 1860
- Patee, R. K. 2847
- Patel, T. R. 2848
- Patil, G. P. 4046
- Patterson, V. B. 1201, 2849-2851, 2900, 3141, 3143, 3614
- Pauley, S. S. 4279
- Peakall, D. B. 2855-2858
- Pearce, P. A. 622-625, 1034, 1035, 2852-2858, 2952
- Pease, S. H. 1748
- Peirson, H. B. 2859-2874
- Pelletier, M. 2875, 2876, 3474, 3475
- Pendrel, B. A. 2165, 2877-2881
- Penney, G. H. 2199, 2882, 2883
- Pepper, J. H. 1621
- Percy, J. E. 2884-2888, 4062, 4063
- Percy, K. E. 2909
- Perring, F. H. 1699, 4054

- Perron, J. M. 2037, 2828, 2829
- Perry, D. F. 2889
- Perry, W. J. 2890
- Peterman, R. M. 1713, 2891, 2892, 4020
- Peters, T. M. 8
- Peterson, J. 2893
- Peterson, J. W. 2894, 2895
- Peterson, L. G. 1972
- Peterson, R. H. 2896
- Pettinger, L. F. 2897, 2898
- Petty, J. 1201, 1695, 1696, 2851, 2899-2902, 3141-3143
- Pfister, R. D. 703, 705
- Phillips, W. 2903, 3400
- Picot, J. J. C. 2904
- Piene, H. 2581, 2905-2911
- Pieper, G. R. 2046, 2912, 2913
- Pierce, J. 932, 2914
- Pierce, W. R. 1270
- Pietroski, J. T. 2915
- Pillmore, R. E. 2916
- Pilon, J. G. 464, 2917
- Pistell, A. 2918
- Pitel, J. A. 1144
- Platta, M. 3011
- Plowright, R. C. 2919-2921, 3734
- Pogue, M. G. 1982, 2922
- Polk, R. B. 4279
- Pollett, F. C. 2923
- Pomerleau, R. 961, 962
- Poole, R. W. 2924
- Popp, M. P. 285
- Potter, C. 1193
- Potvin, F. 2925
- Poulin, H. 2831, 2832, 2926-2928
- Poulter, F. 1410
- Powell, D. S. 2929
- Powell, G. R. 2930
- Powell, J. A. 2932-2935
- Powell, J. M. 2931
- Pratt, D. 1044
- Prebble, M. L. 203, 320, 454, 636, 637, 994, 1688, 1771, 1945, 2476, 2596, 2598, 2606, 2735, 2804, 2936-2952
- Preisler, H. K. 3131, 3133
- Prentice, R. M. 1674, 2953-2955, 4091
- Preston, J. 2114
- Price, I. M. 2952, 3104
- Price, P. W. 465
- Prielipp, D. O. 294, 1439
- Priesner, E. 2956
- Puech, A. A. 2957

Purvis, B. 3799	Reeks, W. A. 204-209, 3023-3031
Rabb, R. L. 1324, 2392, 3800, 4053	Reeves, R. M. 1132, 3032
Rabeni, C. F. 1464, 1791, 2958-2962	Regniere, J. 1268, 1901, 3033-3037
Radke, C. D. 3062	Rehacek, J. 3521
Rafferty, J. E. 1130	Reich, W. J. 1551
Ragenovich, I. R. 2840, 2842, 2963-2966, 3702	Reichenbach, N. G. 3038-3042
Raimo, B. J. 2967-2971	Reiners, W. A. 1712
Rainey, R. C. 1033, 1540, 2972-2974	Remington, C. L. 3043
Ramaswamy, S. B. 2975-2977	Renault, T. R. 643, 2467, 2484-2487, 3044-3048, 3499, 3993, 4100
Randall, A. G. 478, 479	Rendell, D. H. 3049
Randall, A. P. 158, 1191, 2978-2992, 3487	Renlund, D. W. 323, 326-328, 336-338, 1077, 1618, 3050-3061
Rappaport, N. G. 2993, 3132	Renwick, J. A. A. 3062
Raske, A. G. 156, 456, 626, 1083, 1173, 1526, 2468, 2690, 2794, 2799, 2800, 2923, 2994-3002, 3965	Resh, V. H. 4046
Ratsch, H. C. 2046	Retnakaran, A. 156, 1517, 1518, 3063-3092, 3137, 4064
Ray, D. G. H. 582, 595, 596	Reynolds, E. K. 352, 353
Razowski, J. 3003	Reynolds, L. M. 625, 1034, 2858
Rea, J. C. 165, 1665, 1749, 2052	Rhoades, D. F. 3093
Read, R. A. 4279	Rice, J. 3094
Ream, R. R. 2763	Richardson, E. M. 238, 3095, 3096
Reams, G. A. 514, 515, 3004, 3273, 4024	Richardson, J. 621, 626, 737, 2561
Reardon, R. C. 1892, 1893, 2079, 3005-3016	Richmond, C. E. 2147, 3097-3100, 3133
Redak, R. A. 746, 747, 3017	Richmond, H. A. 3101-3103
Redmond, D. R. 2661, 3018-3021, 3621	Richmond, M. L. 2916
Reed, F. L. C. 3022	Rick, A. M. 3104

- Riley, J. L. 3424
- Ritter, F. J. 3245
- Robbins, K. 2695
- Robbins, R. G. 932
- Roberge, M. 1435
- Roberts, B. A. 3105
- Roberts, J. R. 150, 509, 597, 801, 1009, 1370, 1715, 2855, 2919, 2987, 3680, 3985, 4259
- Roberts, R. B. 241, 1690, 2913, 3106-3109, 3311
- Robertson, J. L. 998, 1360, 1479, 1518, 1641, 2147, 2151, 2819, 2993, 3087, 3110-3140, 3269, 3270, 3633-3637, 3640, 4177
- Robins, J. K. 3141-3143, 3828
- Robinson, F. C. 3144
- Robinson, L. A. 3145
- Robison, D. J. 3146, 3147
- Rodd, F. H. 2920
- Roden, P. M. 1611
- Roe, A. L. 3297
- Roelofs, W. L. 818, 3148, 3247, 3385, 4065
- Rogan, R. G. 2539, 2540, 2546, 2554, 3149-3155, 4248
- Rogers, T. J. 3156-3163, 3678, 3702, 3785, 4283
- Rohrmann, G. F. 3164
- Rohwer, S. A. 3165
- Ronco, F., Jr. 3166
- Rose, A. H. 3167-3177
- Rose, D. W. 3178, 3179
- Rose, M. R. 1580
- Rosenzweig, M. L. 4046
- Ross, D. A. 3180-3182
- Ross, D. H. 2129
- Ross, R. J. 2821, 2822, 3183, 3184, 3285, 3386, 3387
- Rowe, J. D. 3000
- Rowney, D. L. 921
- Royama, T. 3185-3190
- Ruben, F. L. 3191
- Rudinsky, J. A. 713, 935, 2270
- Rudolph, T. D. 3192
- Ruggles, A. G. 1504, 3193
- Rumpf, D. 3194
- Rumpf, T. A. 3195
- Runyon, K. L. 1806, 1973
- Rush, P. A. 3196
- Rushmore, F. M. 3197
- Russell, R. M. 3122, 3134, 3269, 3270
- Ruth, D. S. 3198, 3199
- Rutledge, R. H. 3200-3203
- Ryan, S. O. 3204
- Ryker, R. A. 3205
- Sacks, P. J. 2772
- Safford, L. O. 919

- Safranyik, L. 653, 934, 1443, 2357, 2391, 3307, 3373, 3638
- Sajan, R. J. 1222, 3206, 3207
- Sakai, T. T. 3108
- Salonius, P. O. 1178, 3208, 3209
- Salter, E. C. 784, 785
- Sanders, C. J. 31, 43, 44, 48, 101, 147, 152, 153, 156, 226, 250, 266, 311, 312, 372, 383, 395, 445, 449, 472, 473, 583, 602, 606, 634, 644, 652, 701, 722, 728, 745, 752, 849, 874, 886, 893, 897, 899, 927, 933, 1032, 1039, 1040, 1072, 1079, 1080, 1157, 1271, 1272, 1293, 1330-1333, 1376, 1389, 1390, 1441, 1442, 1477, 1478, 1527, 1589, 1607, 1608, 1663, 1741, 1750, 1770, 1776, 1779, 1831, 1834, 1857, 1903-1907, 1921, 1958, 1975, 2061, 2089, 2115, 2134, 2135, 2209, 2321, 2390, 2420, 2421, 2513, 2514, 2539, 2540, 2555, 2556, 2696, 2697, 2722, 2725, 2726, 2738, 2786, 2790, 2830, 2889, 2904, 2905, 2995, 2996, 3002, 3005, 3006, 3033, 3037, 3110, 3144, 3146, 3149, 3150, 3210-3261, 3266, 3267, 3277, 3290, 3325, 3343, 3346, 3359, 3383, 3385, 3397, 3399, 3434, 3440, 3526, 3541, 3555-3557, 3601, 3607, 3622, 3623, 3636, 3641-3644, 3652, 3676, 3753, 3754, 3786-3788, 3802, 3854, 3964, 3991, 4001-4003, 4005, 4012, 4027, 4040, 4065, 4137, 4138, 4146, 4161, 4227, 4236, 4237, 4276, 4281, 4282, 4291, 4297, 4298
- Sandifer, S. H. 3262
- Sando, R. W. 3263
- Sandquist, R. E. 3264
- Sargent, J. E. 3265
- Sarrazin, R. 597, 598
- Sartwell, C. 933, 936, 3266, 3267
- Sassaman, J. F. 3268
- Saterlie, S. F. 1129
- Savin, N. E. 3122, 3134, 3138, 3269, 3270
- Schabas, W. 3600
- Schaefer, G. W. 1540
- Schaffner, J. V., Jr. 3271
- Scharpf, R. F. 1298
- Schaufler, D. 1044
- Schiltz, H. M. 842, 843, 3272, 3273, 4024
- Schmid, J. M. 3274-3279
- Schmidt, D. 3280
- Schmidt, F. H. 3281-3284
- Schmidt, J. O. 3285-3289, 4163
- Schmidt, W. C. 701, 703, 1281-1284, 1551, 3290-3297
- Schmiege, D. C. 61, 338, 339, 1661, 2158, 3298-3301
- Schmitt, D. M. 26, 50, 475, 480, 719, 724, 842, 850, 884, 1045, 1062, 1488, 1568, 1574, 1579, 1662, 1778, 1806, 1836, 2078, 2215, 2427, 2683, 2770, 2929, 3244, 3302-3304, 3345, 3381, 3411, 3412, 3427, 3529, 3576, 3687, 3826, 4016, 4244, 4250
- Schmitt, M. D. C. 3305
- Schomaker, M. 2047
- Schönherr, J. 3306, 3307
- Schooley, H. O. 2468, 2999, 3308-3310
- Schreiner, E. J. 650
- Schroen, C. K. 3311
- Schuh, B. A. 323

Schwandt, J. W. 1473, 1823, 2114, 2117-2119, 3312	Shaw, D. D. 2488, 3333, 3334
Schwartz, J. L. 3313	Shaw, G. G. 3335-3341
Scott, D. O. 1496, 1497, 3314, 3315	Shaw, W. H. 3342
Scott, D. W. 3592	Shea, K. R. 3343
Scuderi, J. A. 3316	Shea, P. J. 1984, 3344, 3345, 3378, 4178-4181
Seabrook, W. D. 21-24, 359, 1145, 2527-2531, 2820-2824, 3183, 3184, 3285-3289, 3317, 3553, 3554	Shearer, R. C. 759, 1285, 1286, 3296, 3297, 3346-3349
Seal, D. T. 1199, 3570	Shearer, W. 3350
Searcy, J. L. 50, 480, 1045, 1806, 3302, 3345, 3411, 3687, 3826, 4250	Sheedy, G. 3351
Seaton, J. H. 2578, 2579	Sheehan, K. 802, 1907
Sechser, B. 3318	Sheldon, L. 1792
Secrest, J. P. 3319-3321	Shenefelt, R. D. 1077, 2012, 3352
Seegrist, D. W. 3322	Shepard, R. K. 3353
Seidel, K. W. 3323	Shepherd, R. F. 849, 910, 1525, 1700, 2392, 3249, 3354-3373, 3756, 3758
Selin, L. O. 2041	Sherburne, J. A. 1069, 3374
Selser, J. 1146	Shewell, G. E. 3375
Sewell, C. D. 3324	Shigo, A. L. 969, 3376
Seymour, R. S. 1049, 1068, 3325-3328	Shoemaker, C. A. 1334, 1336, 1777, 2785, 3377
Shackleton, P. 3329	Shon, F. L. 3378
Shaffer, R. 3166	Shore, T. L. 32, 2393, 4255, 4256
Shapiro, M. 3330	Shortle, W. C. 471, 969, 3376, 3379-3381
Sharon, E. M. 2971, 3331	Shottafer, J. E. 1313, 3382
Sharpnack, D. A. 4178	Shultz, A. W. 1019
Shattuck, S. O. 3332	Sibal, P. V. 503

- Silk, P. J. 35-38, 1131, 2821, 3254, 3383-3388, 4162, 4163
- Silver, G. T. 2538, 3389-3392
- Silversides, R. H. 3756, 3758
- Simmons, G. 3426
- Simmons, G. A. 305, 357, 840, 841, 1194, 1337, 1367, 1368, 1379-1382, 1392, 1685, 1908, 1909, 1915, 1916, 2008, 2011, 2070, 2073, 2539, 2540, 2543-2554, 2670-2673, 2759-2761, 2903, 3149-3155, 3393-3419, 3442, 4238, 4247-4249
- Simon, K. A. 3420
- Simonini, D. 4059
- Simpson, L. J. 3421-3423
- Sims, R. A. 3424
- Sinclair, S. 3426
- Sinclair, S. A. 219-222, 503, 1291, 1292, 1491, 3419, 3425, 3427-3432
- Singh, P. 4026
- Sippell, W. L. 994, 1763-1769, 1771, 3433-3441
- Sisojevic, P. 1645
- Sivasubramanian, P. 2823, 2824
- Skogerboe, G. V. 802, 898, 1323
- Slessor, K. N. 1521, 1525, 2424, 2425, 2428
- Sloan, N. F. 3418, 3442
- Slocum, S. S. 2322, 2327
- Smirnoff, W. A. 156, 2606, 3443-3493
- Smith, A. H. 6
- Smith, B. C. 833, 3494
- Smith, B. E. 3207
- Smith, C. C. 505, 1191, 3495-3499
- Smith, C. R. 1755
- Smith, D. B. 3500
- Smith, G. E. 1974
- Smith, G. G. 4309
- Smith, G. J. 1201, 2851, 2901, 2902, 3141-3143, 3501, 3502
- Smith, K. C. 3135-3138
- Smith, K. L. 1773, 2421
- Smith, L. 3091, 3092
- Smith, P. 350
- Smith, R. F. 3503, 3504
- Smith, S. 728
- Smith, S. G. 3505-3510
- Smith, T. D. 2880, 3511-3518
- Smith, T. M. 358, 1879
- Snowden, P. 3519
- Snyder, T. E. 3520
- So, Y. P. 1679
- Sohi, S. S. 141, 378, 1208, 3521-3523, 4211
- Solberg, C. T. 2108, 3524, 3525
- Solomon, D. S. 514-516, 1646, 1647, 1970, 1971, 3273, 3526-3530
- Sonderman, D. L. 3531
- Sonntag, N. 2414

- Soper, R. S. 3532, 3973-3975
- Sorenson, D. D. 3533
- South Idaho Forest Pest Action Council 3534
- Southard, S. G. 1751, 1752, 2051, 3535
- Souto, D. J. 48, 2349, 2509, 3536-3538
- Sower, L. L. 849, 931, 933, 936, 3539
- Spearing, A. M. 821, 3140, 3640
- Specklemire, L. 2114
- Speers, C. F. 1147, 1828, 1829
- Spencer, C. C. 3540
- Spies, C. J., III 1050, 1051, 3541-3544
- Spitzer, W. O. 3545, 3546
- Spruce Budworm Action Committee 3547, 3548
- Spurgeon, D. 3549
- Sreenivasam, D. 324
- Srivastava, N. 653, 656, 657, 663-666, 3550, 3551, 3790
- Stackerud, M. 2515, 3148
- Stadler-Steinbruchel, M. 3554
- Staedler, E. 3552-3554
- Stage, A. R. 3555
- Stairs, D. J. 1463
- Stairs, G. R. 3040-3042, 3556-3566
- Staley, M. 2414
- Stanley, J. G. 1464, 2350, 2793, 2959, 2960
- Stark, D. A. 166, 2347, 3567-3569, 3649
- Stark, R. W. 31, 43, 44, 152, 153, 226, 266, 311, 312, 363, 372, 445, 449, 472, 473, 583, 602, 606, 644, 652, 701, 728, 745, 752, 874, 886, 893, 897, 899, 927, 933, 1032, 1039, 1040, 1072, 1079, 1080, 1157, 1271, 1272, 1293, 1330-1333, 1389, 1390, 1441, 1442, 1589, 1607, 1608, 1663, 1741, 1776, 1779, 1831, 1834, 1857, 1903-1907, 1921, 1958, 1975, 2089, 2115, 2134, 2135, 2209, 2321, 2390, 2420, 2421, 2513, 2514, 2539, 2540, 2555, 2556, 2696, 2697, 2722, 2726, 2738, 2790, 2889, 2904, 2905, 2995, 2996, 3002, 3005, 3006, 3033, 3110, 3146, 3149, 3150, 3217, 3220, 3221, 3230, 3236, 3240, 3266, 3267, 3277, 3290, 3325, 3343, 3346, 3359, 3383, 3397, 3399, 3440, 3526, 3541, 3555-3557, 3570, 3571, 3601, 3622, 3623, 3636, 3641-3644, 3652, 3676, 3753, 3754, 3787, 3788, 3802, 3854, 3991, 4001-4003, 4005, 4012, 4027, 4040, 4137, 4146, 4161, 4227, 4236, 4237, 4276, 4281, 4282, 4291, 4297, 4298
- Staton, C. R. 3572
- Stearns, Conrad and Schmidt Consulting Engineers, Inc. 3573
- Stedinger, J. R. 1334, 1336, 2785, 3574-3577
- Steel, V. 1947, 3578
- Stehr, G. 1408, 1612, 1613, 3579-3586
- Stein, C. R. 3587-3589, 3606
- Stein, J. D. 3590, 3591
- Stelzer, M. J. 3592, 3593
- Stephan, B. R. 2354
- Sterner, T. E. 2236, 2237, 3594-3599
- Stevens, F. 3600
- Stevens, R. E. 717, 718, 3601-3606, 4280
- Stevens, W. C. 3607
- Stevenson, R. E. 3608

- Stewart, D. K. R. 4260
- Stewart, J. F. 2488, 3609
- Stewart, K. E. 3610
- Stewart, R. B. 328, 333, 772
- Stewart, R. E. 3611, 3612
- Still, G. N. 1202, 1695, 1696, 2849-2851, 2900, 3141, 3142, 3613-3615, 4251
- Stillwell, M. A. 3616-3621
- Stipe, L. E. 492, 502, 1996, 2843, 3007, 3622-3631
- Stock, M. W. 744, 1360, 3111, 3139, 3140, 3632-3640, 4174
- Stocks, B. J. 2999, 3641
- Stoddard, W. F. 352, 354
- Stone, D. M. 781-787
- Stoszek, K. J. 3642-3645
- Stovall, F. S. 2914
- Strong, L. A. 3646
- Strongman, D. 2493
- Struble, D. 1917, 3647-3649, 3803, 3813
- Strunz, G. M. 156, 352, 355, 3650, 3651
- Sullivan, C. R. 4136
- Summers, M. D. 1974
- Sundaram, A. 1173, 3652
- Sundaram, K. M. S. 1179
- Susut, J. P. 2851, 2900-2902, 3141-3143, 3653
- Sutherland, E. K. 3679
- Sutherland, J. R. 3199
- Sutton, W. J. 781-787, 2998, 3001, 3002, 3654
- Suzuki, S. 3655
- Swaine, J. M. 3656-3674
- Swan, H. S. D. 1435
- Swenson, C. L., Jr. 3675
- Swetnam, T. W. 3676-3679
- Swier, S. R. 46
- Syme, P. D. 1757, 1772, 1773, 2094, 2421
- Symons, P. E. K. 1556, 3680-3682
- Szittner, R. B. 1521, 2426, 2664, 3683
- Tagestad, A. D. 3684
- Takekawa, J. Y. 1441, 1442, 3685, 3686
- Talerico, R. L. 19, 314, 355, 1335, 2327, 2346, 2356, 2393, 2557, 2848, 3293, 3305, 3371, 3687-3689, 3739, 4013, 4245
- Tan, S. H. 1131, 2821, 3385-3387, 4162, 4163
- Tang, C. S. 1316, 2196
- Tarrant, R. F. 483
- Tatterson, V. B. 3142
- Taylor, R. G. 2001, 2023-2025
- Taynton, S. 3690
- Tegethoff, A. C. 1969, 2843
- Teillon, H. B. 3691, 3692
- Telfer, W. G. 3693-3702

Terrell, T. T. 966, 967, 1088, 2342, 2343, 3703-3733, 3851

Teskey, A. G. 995

Thaler, G. R. 2921, 3734

Thatcher, T. O. 3602

Theroux, L. J. 655, 702, 705, 3348, 3735

Thier, R. W. 1473, 3016, 3312

Thomas, A. W. 2474, 2491, 3286, 3651, 3736-3746

Thomas, H. A. 3747

Thomas, J. B. 1424, 1425, 1454, 3748

Thompson, C. G. 3749

Thompson, H. E. 1655, 1656

Thompson, M. A. 3679

Thompson, R. G. 2906, 3750

Thompson, W. R. 3751

Thomson, A. J. 33, 34, 3752-3759, 3971

Thomson, H. M. 3760-3769

Thomson, J. D. 2921

Thomson, M. G. 3392

Thomson, M. J. 3770-3772, 4112-4117

Thornbury, J. R. 3773

Thornton, D. G. 3320, 3321

Thorsteinson, A. J. 466

Thurston, A. S. 3774, 3814, 3815

Thurston, H. 3775-3777

Tidsbury, R. C. 2668, 2669, 2851, 2900, 3141, 3142, 3615

Tiernan, C. F. 3349, 3778, 4183

Tilles, D. A. 3779

Timms, J. F. 1294, 3348

Timonin, M. I. 3780

Timpano, S. A. 490

Tinsley, T. W. 2120

Tinus, R. W. 4012

Titterington, R. W. 887, 888

Titus, F. A. 3781, 3782, 3992, 3993

Toko, H. V. 3783-3785, 3850, 3851

Tombler, G. 1071

Tomkinson, B. 352

Tomkinson, D. 352

Tomlin, A. D. 4310

Tomlinson, J. W. 3786

Torgersen, T. R. 653, 654, 657-666, 3550, 3551, 3787-3790

Tothill, J. D. 3674, 3791-3798

Tovar, D. C. 1649

Tracey, A. S. 1525

Tracey, H. B. 3799

Traer, M. G. 1740

Treat, A. E. 3800

Trefts, H. 2007

- Tremblay, P. H. 1721
- Trial, H., Jr. 822, 1015, 1017, 1917, 3647-3649, 3801-3815
- Trial, J. G. 1464, 1465, 1958, 3816-3826
- Triandafillou, P. H. 516, 3328
- Tripp, H. A. 1308, 3827-3831
- Trostle, G. C. 231, 232, 4295
- Trotter, S. J., Jr. 3282
- Tsomides, L. 3832
- Tucker, J. E. 3833
- Tucker, S. 521, 2020
- Tunnock, A., Jr. 3834
- Tunnock, S. 766, 1327, 1329, 1571, 1823, 3835-3851
- Turnbull, A. L. 3852
- Turner, K. B. 3853, 4134
- Turnipseed, S. G. 2844
- Twardus, D. B. 1541, 2295, 2344, 3266, 3267, 3854-3859
- Twinn, C. R. 3860
- Tyrrell, D. 156, 3064
- Tysowsky, M., Jr. 227, 239-241
- U.S. Department of Agriculture, Bureau of Entomology and Plant Quarantine 2253, 3861
- U.S. Department of Agriculture, Division of Forest Insect Investigations 2254
- U.S. Department of Agriculture, Forest Insect Laboratory 3862
- U.S. Department of Agriculture, Forest Service 236, 1018, 1182, 1274, 1276, 1327, 1638, 2255-2264, 2913, 3316, 3842, 3863-3959, 4225, 4314
- Underwood, G. R. 1358, 1359, 3031
- Underwood, P. W. 491, 1386, 1387
- Ung, C. H. 3960
- Unger, L. S. 3961, 4266, 4267
- Union Carbide Corporation 151, 174, 365, 741, 983, 1042, 1185, 1542, 2082, 2379, 2685, 2957, 3095, 3191, 3262, 3801, 4088
- University of Maine, School of Forest Resources 3962
- Vadas, R. L. 2329
- Vago, C. 14
- Valcarce, A. 1986
- Valenta, Z. 3183, 3289
- Valero, J. R. 3474, 3475, 3484-3486, 3488-3492
- Valli, V. E. 3963
- van Fraassen, A. M. 3964
- van Frankenhuyzen, K. 3255
- van Nostrand, R. S. 3965
- van Raalte, G. D. 1944, 3599, 3966-3969
- Van Sickle, G. A. 33, 34, 817, 1309-1311, 1358, 1359, 3182, 3369, 3755, 3759, 3970, 3971, 4253-4256
- Vandenberg, J. D. 3972-3975
- Vandenburg, D. O. 3976
- VanDerwerker, G. K. 1067, 2073
- Varley, G. C. 3977

- Varty, I. W. 1173, 2488-2491, 2952, 3318, 3978-3995, 4311
- Veness, J. C. 210
- Vezina, P. E. 892
- Videnova, E. 1269
- Vincent, A. B. 2661, 2724, 3996-3998
- Vinson, S. B. 3999
- Visser, J. H. 15
- Volney, W. J. A. 2084-2087, 2474, 4000-4009, 4040
- Volpe, G. 2276
- Voluntary Planning Committee 4010
- von Weissenberg, K. 2354
- Vostrowsky, O. 611
- Wagg, J. W. B. 4011
- Wagner, M. R. 323, 470, 4012, 4013
- Waite, R. A. 2269, 2273
- Walker, E. B. 4014, 4016
- Walker, H. D. 897
- Walker, K. C. 4015
- Wall, R. E. 2908
- Wallace, D. R. 3256
- Wallace, W. L. 373
- Walley, G. S. 4017-4019
- Walmsley, M. L. 517
- Walters, C. J. 1715, 4020
- Walton, G. S. 2079, 4021, 4022, 4181-4183
- Ward, R. 1498
- Warner, K. 4023
- Warner, W. S. 3273, 4024
- Warren, G. L. 4025, 4026
- Warren, G. R. 2999, 4027
- Washburn, R. I. 4028-4033
- Waterland, T. M. 4034
- Waterman, A. M. 4043
- Waters, W. E. 295, 968, 1713, 1774, 2087, 2346, 2568, 2988, 3083, 3461, 4004, 4005, 4007, 4009, 4035-4046
- Watt, K. E. F. 4047-4053
- Way, M. J. 4054
- Wear, J. F. 1541, 2095, 4055
- Weatherby, H. 4056
- Weatherston, J. 1427, 2201, 2884, 3257, 3258, 4057-4065
- Weaver, C. A. A. 1180
- Webb, F. E. 211-213, 1808, 1809, 2197, 2662, 4066-4103
- Webb, L. S. 4104, 4105
- Webb, R. F. 4106
- Webb, W. E. 844
- Weber, F. P. 769, 4107, 4108
- Weed, D. 4109
- Weetman, G. F. 262

Wegwitz, E. 32, 34, 2584
 Wein, R. W. 1419, 4110
 Weinberger, H. F. 2131
 Weir, H. J. 1221, 4111-4117
 Weiss, M. J. 7, 4118
 Wellington, E. F. 4119-4121
 Wellington, W. G. 1913, 4122-4136
 Wellman, J. D. 607
 Wellner, C. A. 1498
 Welsh, D. A. 4137, 4138
 Welty, C. 1751
 Wenner, B. J. 542
 Werner, R. A. 1719, 4060
 Wert, S. L. 4139
 Wessela, C. P. 4156
 West, A. S. 2126, 2127
 West, T. F. 4140
 Westveld, M. 2337, 4141-4145
 Whalen, M. M. 396
 Whitcombe, L. 234
 White, E. H. 3146, 3147, 3305
 White, F. M. M. 1622
 White, M. B. E. 901, 904, 905
 White, W. B. 2693, 2694, 4146
 White, W. W. 4147
 Whiteside, J. M. 1753, 2095, 4148-4156
 Whitney, N. J. 2493
 Whitney, R. D. 29, 246, 1756, 4157
 Whitten, R. R. 4158
 Whyte, G. L. 4159
 Wickman, B. E. 4160
 Wienberger, P. 4161
 Wiesner, C. J. 1264, 2821, 3386, 3387, 4162-4164
 Wildish, D. J. 1195
 Wile, B. C. 4165
 Wilford, B. H. 4166-4170
 Wilkes, A. 4171-4173
 Wilkinson, N. W. 3143
 Willcocks, A. J. 1346
 Willhite, E. A. 3638, 4174
 Williams, C. B., Jr. 1360, 4175-4184
 Williams, J. R. 1676, 4185
 Williams, L. E. 2578-2580, 4102
 Williams, R. E. 497, 2370
 Wilson, D. A. 4186
 Wilson, G. G. 156, 2885, 3064, 4187-4214
 Wilson, L. F. 306, 2671, 4215-4224
 Wilson, S. T. 3417
 Wing, M. R. 4225
 Wingard, C. 4226

- Winget, C. H. 4227
- Winieski, J. A. 650
- Winston, D. A. 1346
- Wisconsin Conservation Department 4228-4234
- Wishart, G. 4235
- Witham, J. W. 1787
- Witteman, J. 2853
- Witter, J. A. 1337, 1383, 1698, 1779, 1886, 2134-2146, 2334, 2335, 2533, 2534, 2539, 2540, 2543, 2544, 2546-2554, 2771, 2772, 2977, 3149-3151, 3153-3155, 4236-4250
- Wong, H. R. 2931, 4251
- Wong, J. 237, 608, 4252
- Wood, C. S. 58, 59, 856, 1215, 2005, 2587, 4253-4256, 4271
- Wood, G. W. 4257-4260
- Wood, R. O. 2585, 4261-4272
- Woodhouse, B. 1580
- Woodley, N. E. 3779
- Woodwell, G. M. 2179, 4273-4275
- Woolley, B. 4276
- Wortendyke, J. 1541
- Wright, B. 4277
- Wright, B. S. 4278
- Wright, J. W. 4279
- Wright, K. H. 714, 1414, 2095, 2096, 4280
- Wright, L. 165
- Wulf, N. W. 492, 498, 502, 701, 3162, 4281-4283
- Wygant, N. D. 2783, 2784, 4284-4287
- Yacavone, P. F. 4288, 4289
- Yamvrias, C. 4290
- Yasinski, F. M. 771
- Yatagai, M. 352
- Yates, H. O., III 1649, 3347
- Yates, W. E. 4291
- Young, B. 4292-4294
- Young, C. L. 3284
- Young, R. W. 234, 609, 1546, 3629, 4295, 4296
- Youngs, L. C. 662, 4297-4300
- Yuill, J. S. 1812, 4301-4303
- Yule, W. N. 159, 2952, 3994, 4304-4311
- Zach, R. 4312
- Zalkow, L. H. 354
- Zarnovican, R. 4313
- Zehngraff, P. J. 1704
- Zimet, M. 1552
- Zinkl, J. G. 4314
- Zitko, V. 2896
- Zwolfer, H. 699, 4315-4317
- Zylstra, B. F. 629, 2989, 2992, 4318

